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An analysis of tank gap in military balance between Republic of Korea and North Korea.

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THESIS

AN ANALYSIS OF TANK GAP IN MILITARY BALANCE BETWEEN REPUBLIC OF KOREA AND NORTH KOREA

by

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An Analysis of Tank Gap In Military Balance Between Republic Of Korea and North Korea.

by

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Submitted in partial fulfillment of the
requirements for the degree of

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December 1989

ABSTRACT

At present, some analysts advocate (both ROK and U.S.) a reduction or withdraw of U.S. troops from the Korean Peninsula and a return of all the rights of command to the ROK government. This will increase the risk of another war on the Korean Peninsula. If war were to break out, Korea might be devastated economically, returning the people to the poverty levels of 1953. Also, war on the Korean Peninsula might lead to, or precipitate, another World War because the powerful allied nations (both U.S. and USSR) would participate in that war. Therefore, peace on the Korean Peninsula is very important and can be achieved if the ROK and NK perceive each other as possessing balanced military strength. NK currently has superior military strength. So to maintain peace, if the U.S. were to withdraw, it would be necessary for the ROK government to increase defense spending. The purpose of this thesis is to identify the tank gap as a major of military strength and provide some ideas to the ROK goverment for the military equipment modernizing plan. This thesis provides numerical quantitative assessment of the current balance of tank forces between the ROK and NK, as well as a dynamic assessment using the Lanchester combat model.

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I. INTRODUCTION

There is no doubt about the geopolitical importance the Korean Peninsula holds in Northeast Asia. Located in the center of triangular competition among China, the Soviet Union and Japan, Korea has held a strategic position, though in varying degrees at different times. Its control was always a prerequisite for hegemony in Northeast Asia. [Ref. 1: p. 13]

Since the end of the Korean War in 1953, the Republic of Korea (ROK) and North Korea (NK) have maintained their military forces in a high state of readiness. The dangers of a war on the Korean Peninsula extend beyond the two Korean states to their major allies who would undoubtedly become involved in a major Korean conflict. Thus stability in this strategic area has been a key element in determining policy for the major powers as well as the two Koreas.

Although there has been relative stability on the Korean Penisula since the end of the Korean War, the strategic environment has been in a continual state of change. Until recently the strategic environment was largely determined by the quantity and quality of arms supplied to NK and ROK by major allies. However, since the late 1960's, both NK and ROK have pursued policies to develop their own indigenous arms industries, expanded their defense budgets, and implemented modernization programs for their militaries. A consequence of these developments has been an increasing military competition between NK and ROK and a reduction in the ability of the major power allies to influence the actions of the Koreans.

This thesis analyzes the tank gap between NK and ROK as measured by its military strength and proposed a framework for the ROK armored structure plan.

A. BACKGROUND

In August 1943, U.S. President Franklin D. Roosevelt and British Prime Minister Winston Churchill proclaimed the Atlantic Charter, giving hope to people, like the Koreans, who had been forcibly deprived of their sovereignty. [Ref. 1: p. 13]

The spirit of the Atlantic Charter was given a more concrete shape in the Cairo Declaration adopted in November 1943 at a meeting of President Roosevelt, Prime Minister Churchill, and Generalissimo Chiang Kai-shek of the Republic of China, held to discuss problems which might arise after the war. Concerning the future of Korea,

the declaration stated: "... mindful of the enslavement of the Korean people, the aforesaid Three Powers are resolved that Korea shall become free and independent in due course." [Ref. 1: p. 14] Through the declaration, the Allied Powers promised democratic and unified independence to the Korean people after a certain transitional period. The Cairo Declaration was reconfirmed by the Potsdam Declaration in July 1945, and the Soviet Union subscribed to the declaration when it declared war on Japan in August 1945.

In the meantime President Roosevelt, Prime Minister Churchill, and Soviet Premier Joseph Stalin met in Yalta in February 1945 to discuss matters concerning Soviet participation in the war against Japan and treatment of post-war questions. In return for joining in the war against Japan, with which it was bound by a treaty of nonaggression, the Soviet Union was promised at the Yalta Conference that it would regain its former territory and various other concessions in the Far East. [Ref. 1: p. 14]

On August 15, 1945, Japanese Emperor Hirohito surrendered unconditionally to the Allied Powers. When Japan notified the Allied Powers of its intention to surrender unconditionally, the U.S. Government decided, mainly for military considerations, that Soviet troops would accept the surrender of Japanese troops in Korea in areas north of the 38th parallel while the American troops would do the same south of the parallel. The decision became concrete in Geneal Order No. 1 issued by General Douglas MacArthur, Supreme Commander of the Allied Powers in the Pacific, on September 2 that year (effective five days later). [Ref. 1: p. 14]

The foreign ministers of the three powers- the United States, Great Britain, and the Soviet Union- held a conference in Moscow on December 16, 1945; Ministers Byrnes, Bevin, and Molotov reached an agreement on December 26 concerning the establishment of a unified provisional Korean government. The Republic of China later took part in the meeting known as the Moscow Conference of the Four Ministers. [Ref. 1: p. 16]

Regardless of Allied Nations effort to establish a unified provisional Korean government, ROK and NK established their own government. ROK's elections were held on May 10 1948. On August 15 1948, the government of ROK was inaugurated with Syngman Rhee as its first president. NK held it's own elections on September 9 1948, and established its government.

The North Korean government has maintained that two essential elements for successful reunification are: (1) the withdrawal of all American forces from ROK and the end of American involvement, and (2) the overthrow of the Republic Of Korean gov-

ernment and the establishment of a patriotic democratic left-leaning government that would agree to reunification on North Korea's terms. Based on these elements military competition has increased on the Korean Peninsula. [Ref. 2: p. 253]

Both ROK and NK are preparing for a major war at an increasing pace. Production and buying significantly more weapons for ever-increasing the readiness of their forces, the Korean peninsula is already one of the world's most militarized areas.

The high level of tension between North and South Korea in recent years, due to incidents such as the Rangoon bombing and the downing of the KAL jetliner has once again focused attention on the military situation on the Korean peninsula. These tensions, coupled with the deteriorating health of Kim Il Sung, who vowed to unify the Koreas before his death, and the increasing economic disparity between the North and South have led many to conclude that the chances of war are greater now than at any time since 1953.

Based upon existing force sturctures ROK has been unable to delay a NK tank attack in the Korean War likewise NK has been unable to defend themselves from an air attack by ROK in U.S. aircraft. Therfore NK built almost of all their military facilities underground. On the other hand, The ROK government has constucted many tank obstacles to protect themselves against a NK tank attack and delay their speed. Additionally the ROK wants, to increase its number of tanks to be on the par with NK currently. There is a large disparity between the number of tanks between the ROK and NK.

This thesis examines the extent of a tank gap between the two Koreas and identifies factors that influence conventional balance of tank power in war time.

B. THESIS OBJECTIVES

Along the Demilitarized Zone today, the North Koreans have eight corps in their forward area, including four armored corps. One of these corps is a recently reorganized force of three armored divisions composed of medium tanks and supporting mechanized fighting vehicles. NK appears to be rebuilding the armored forces to the levels that existed when NK devastatingly invaded ROK in the early summer of 1950. [Ref. 3: p. 56]

At present, some analysts advocate (both ROK and U.S.) a reduction or withdraw of U.S. troops from the Korean Peninsula and a return of all the rights of command to the ROK government. This will increase the risk of another war on the Korean Penin-

sula. If war were to break out Korea could be devastated economically, returning the people to the poverty levels of 1953. Also, war on the Korean Peninsula could cause another World War because the powerful allied nations (both U.S. and USSR) will undoubtly participate in that war. Therefore, peace on the Korean Peninsula is very important and can be achieved both ROK and NK have balanced military strength. NK currently has superior military strength, so to maintain peace, it is necessary for the ROK government to increase defense spending.

The objectives of this thesis are:

- To compare the tank strength of NK and the ROK as a part of the measure of military strength.
- Evaluate and recommend the tank strength needed by the ROK to establish a balance of power with NK assuming U.S. troops withdrawl from the Korean Peninsula.
- Identify the importance of the U.S. presence on the Korean Peninsula in preventing war.

C. SCOPE, LIMITATIONS AND ASSUMPTIONS

The comparison of the ROK and NK is made in terms of their military strength, especially tank power. Anti-tank weapon are not considered in this thesis because both side's anti-tank numbers are similar with very little power differential. Armored vehicles are also not considered. Comparison between each side is made according to recently declassified data from military reports.

This thesis assumes that each side's tank capabilities are equal to that of major allied nations; thus ROK's tank power is equal to the U.S.'s tank and NK's is equal to the USSR's. It is also assumed that each side's tanks function normally in time of war.

D. METHODOLOGY

The basic form of this study is descriptive. This methodogy involves the collection and evaluation of facts related to the topic. Two comparative methods are used to determine the tank gap between ROK and NK. The first is a numerical comparison method and the second is a dynamic analysis.

The numerical comparison analyzes existing data, from two view points. One view is with U.S. support and the other is without U.S. support. The Static method considers only the total of tank forces available to each side at a given time and it does not account for the progress of fighting or combat losses on either side.

A Dynamic assessments is an appropriate methodology since warfare is a dynamic process. The Dynamic method, which attempts to model the progress of a battle and reflect combat losses, is discussed more fully in chapter IV.

E. ORGANIZATION

This thesis consists of five chapters. Chapter I states the background, objective, scope, limitations, assumptions, and methodology.

Chapter II is an overview of military competition between ROK and NK. In chapter II military development before the Korean war is discussed. Then military competition is evaluated. In competition arms transfers to Korea, arms industry, military expenditures and total military situation on the Korean peninsula are evaluated.

Chapter III examines the numerical and static tank gap between ROK and NK. The organization of armored forces are evaluated and the limitations of the numerical comparison and static comparison method are discussed.

Chapter IV presents the dynamic model. In chapter IV Lanchester's equations are introduced as a dynamic model for applying on the Korean peninsula. Lanchester's Square Law and Linear Law are introduced and discussed in measuring the tank gap between ROK and NK in dynamic situation. The limitations of the Lanchester model on the Korean Peninsula are addressed.

Chapter V make a conclusion based on the proceeding research. The thesis is concluded by determining of there is a reasonable gap in tank power between ROK and NK. It will also address the significance of U.S. forces lacated on the Korean Peninsula as protection should another war occur.

II. AN OVERVIEW OF MILITARY COMPETITION BETWEEN ROK AND NK

NK and the ROK have two of the most militarized societies in the world by any measurement, be it per capita military spending, military spending as percent of government spending and gross national product, or incorporation of the "civilian" population into the military structure.

This chapter introduces the military development before the Korean war in 1950 and the military competition to the present. The arms transfers and arms industry of both NK and ROK are evaluated and show the total military strength of today. This will help in understanding the situation before comparing the tank gap between the two Korea.

A. MILITARY DEVELOPMENT BEFORE THE KOREAN WAR

The quest for military superiority began early between the Koreas. North Korea had established a full-fledged army, with 200,000 regular soliders, by February 1948. Conversely, ROK had about 50,500 soldiers when it was inaugurated in August 1948. [Ref. 4: p. 179]

NORTH KOREA

One of the first acts of the newly-formed North Korean Government was to create a large standing army. Under Soviet guidance, conscription was introduced, military training schools established, and training of cadets and officers begun. The first units were activated in February 1946. By 1947, force levels rose to 150,000, and to 200,000 by 1948. Formal establishment of the Korean People's Army was announced in February 1948--seven months prior to the establishment of the Democratic Republic. [Ref. 5: p. 314]

The Soviet Union was the sole supplier of military equipment to NK between 1945 and 1950. During this time, economic and military aid supplied to the North was estimated to value $56 million dollars. [Ref. 6: p. 41]

REPUBLIC OF KOREA

The buildup of forces in NK went almost undetected by the United States which was preoccupied with the containment of communism in Europe. Thus, when Soviet

and American troops were withdrawn from Korea in 1948, a large military imbalance existed.

The ROK's military was totally inadequate to defend itself against the North Korean invasion in 1950. Although South Korean forces had been provided with some weapons and training, a precaution had been taken by the American Occupation Army to arm South Korean forces with only light defensive weapons. [Ref. 4: p. 181]

Although part of the blame for South Korea's inadequate defense capability can be placed on the U.S., most of the blame must go to the ROK president, Rhee. Former Ambassador John S. Muccio explained the American position:

President Rhee had a very unrealistic attitude toward that whole issue. He thought that the people of the North were waiting for him to arrive on a white charger, that they would all get up and acclaim him, and that Korea would be unified. and ...as many incursions took place north of the 38th parallel, as well as south of it, that tied our hands, there was a danger that aggression would occur from the South. [Ref. 7: p. 16]

Therefore, when the Korean War began in 1950, the ROK's military possessed no tanks, no medium nor heavy artillery, and no combat aircraft.

B. ARMS TRANSFERS TO THE KOREAS

Arms transfers to both NK and ROK played a significant role in the development of their military forces. Until they were able to establish their own indigenous arms industries, both were totally dependent on arms imports to equip their forces. Therefore, the study of arms transfer is a good place to study the military development of both NK and the ROK.

This section will present a chronological study of arms transfers beginning with the prewar period, 1945-1950, followed by an examination of arms transfers during the Korean War, 1950-1953. The study will then shift to an examination of arms transfers by decades.

1. PREWAR, 1945-1950

The prewar time frame is important because of the events that transpired in arms transfers during this period which influenced the course of the war.

NORTH KOREA

The Soviet Union entirely dominated NK during this period. They were the sole supplier of arms, ammunition, gasoline, vehicles, and other military items. Soviet aid, both economic and military, is estimated to have been $56 million between 1945 and 1950. [Ref. 6: p. 241] After the Soviet withdraw their troops in 1949, the North Koreans were provided with large deliveries of tanks, trucks, artillery, and war planes. Included in the 242 Soviet tanks furnished under this aid program were the T-34's which were believed to be the best tank in the world at that time. Also, the 150 war planes supplied to North Korea included modern Il-10 bombers, and Yap-9P fighter planes. [Ref. 8: p. 192]

REPUBLIC OF KOREA

The U.S. approach to ROK before the outreak of the Korean War could best be described as ambivalent. Due to the action of the Rhee Government, the U.S. Occupation Army had equipped ROK only with light arms and mortars, and provided some technical training, but the U.S. had taken "the precaution to arm the ROK Army only with light defensive weapons to preclude any temptation to invade NK. [Ref. 8: p. 20]

2. THE KOREAN WAR, 1950-1953

The Korean War began June 25, 1950, when the North Koreans invaded the South. This shifted the U.S. military assistance program for ROK from limited assistance to direct intervention and massive aid. In turn, NK received comparable aid from the Soviet Union, as well as direct Chinese intervention.

NORTH KOREA

During the Korean War, military aid to NK consisted mainly of aircraft, tanks, and artillery. (See Appendix A) Included in the equipment supplied to NK were 200 jet fighter aircraft, and 450 T-34 tanks.

Although NK received massive Soviet and Chinese support, their armed forces were decimated by the war. Their Army suffered enourmous casualties and equipment losses. Similarly, the Korean People's Armed Forces Air Corps had to completely regroup and retrain due to the enormous losses suffered in the early stages of the war. [Ref. 8: p. 411]

REPUBLIC OF KOREA

Like its enemy, ROK received a tremendous amount of military equipment during the Korean War. (See Appendix B) Included in this aid were over 800 tanks, mostly M-47's or M-48's, and Sherman-types. Unlike NK, ROK did not receive any jet aircraft; ROK relied totally on U.S. air cover. The bulk of the military aid consisted of infantry weaponry commensurate with South Korean capabilities. [Ref. 8: p. 407]

The ROK forces emerged from the war in a little better condition than did those of the North. Although their Army was intact, it relied heavily on the U.S. for support. The ROK Air Force consisted only of limited numbers of older propeller-type aircraft with few supplies. The Navy emerged from the war a little better equipped, but it presented no real threat to NK.

3. THE FIRST DECADE, 1953-1960

By 1955, the Soviets had increased the number of bombers supplied to NK, and by 1956 they had introduced a new aircraft weapon system, the MIG-17 fighters. The agreement stood until 1958, at which time it was voided by the United Nations Command for "alleged North Korean nonadherence."[1] [Ref. 8: p. 416]

NORTH KOREA

The North Koreans channeled most of their resentment toward the Soviets, because of their initiation of the armistice process. Many North Korean leaders directly blamed the Soviets for their failures, and felt that the enormous loss of Korean lives had been in vain.

North Korean forces received 20 Il-28's in 1955, and 100 MIG-17's from 1956 to 1958 to supplement their ageing MIG-15's. In 1959, China supplied North Korea with 80 MIG-15's, and began delivery of Il-28's Chinese support continued in 1958-59 with the transfer of 44 Il-28's, 20 Yak-18's, and 300 Shenyang F-4 aircraft. China also introduced the first supersonic aircraft, the MIG-19, into NK in 1959. Between 1957 and 1960, China increased the North Korean naval capability with the transfer of 24 minesweepers. [Ref. 8: p. 364] Aid to NK between 1953 and 1960 shifted from complete Soviet depence toward an independent course leaning toward Chinese influence.

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1 See Appendix A and B for Arms Transfers to NK and ROK.

REPUBLIC OF KOREA

Military aid to ROK rose steadily throughout the 1950's, peaking between 1958 and 1960. Actual arms transfers to ROK during the fifties were mostly World War II surplus items which were obsolete in U.S. inventories. Additionally, these arms were single weapons (as opposed to weapons systems) which required only minimal maintenance and limited complex spare parts. Although these weapons were outdated in the U.S. inventory, they filled the needs of th ROK Army, and were commensurate with their maintenance capabilities. [Ref. 9: p. 288]

Air assets were an exception in arms transfers. Here the ROK received 110 F-86 fighter-bombers, and nine T-33's. These aircraft matched the quality, but not the quantity supplied to NK during this same time period.

4. THE SECOND DECADE, 1960-1970

NORTH KOREA

NK concluded a Mutual Defense Treaty with the Soviets in 1961 in spite of growing differences. This was not an acceptance of Soviet dominance, however, for in this same year, Kim introduced his Seven-Year Economic Development Plan, defying a Soviet attempt to coordinate and direct all socialist planning efforts. The combination of defiance in economic planning, and the refusal to accept Soviet military command dominance, resulted in the cancellation of all Soviet aid. [Ref. 8: p. 413]

China increased its supply of jet fuel and spare aircraft parts to NK in the early 1960's, even though they were badly needed in China. NK reciprocated by reorganizing its Air Force along Chinese lines. By 1963, the North Koreans had received 400 Chinese built aircraft, including Shenyang 4 (MIG-17), MIG-15's, and 11-28's. According to the Stockholm International Peace Research Institute (SIPRI), NK's Air Force had expanded to 465 combat aircraft by 1964. During the early sixties, the North Korean military strength exceeded ROK's by 200-400 percent. [Ref. 8: p. 413]

As a result of substantial Soviet military aid, the North Korean military forces profited greatly in 1967-1968. By 1967, the North Korean Air Force had over 500 combat aircraft, including 21 MIG-21's, 350 MIG-17's, 80 MIG-15's, and 80 11-28 bombers (over half of which were provided by Moscow). Also provided were 10 Air-

Defense Complexes, including 500 SA-2 missiles.[2] Almost all of NK's heavy army equipment was Soviet supplied. [Ref. 8: p. 413]

A major development of the self-reliance movement in NK was the initiation of construction in an indigenous arms production industry. This independent policy resulted in the development of a self-sufficient small arms industry. By the end of the sixties, NK indigenously produced all of their small arms, including rifles, machineguns, mortars, as well as the ammuntiton for each item.

REPUBLIC OF KOREA

Arms transfers to ROK during the sixties included advanced weapons systems. In 1961, the Nike Hercules, Honest John, and Hawk missiles were first delivered to ROK forces. Sixty F-86 fighter aircraft were also delivered, including approximately 700 advance Sidewinder air-to-air missiles. Although conventional armament continued to flow, and some new systems were introduced, the share of U.S. aid for new procurement fell during this period. By 1964-65, almost 80 percent of military aid granted was for ammunition, parts, food, and training. [Ref. 8: p. 417]

Begining in 1965, partially as part of the quid pro quo, the U.S. started updating the ROK forces. In 1965, F-5 Freedom Fighters were delivered to supplement and replace ageing F-86's. Additionally, the U.S. promised to fully equip three of ROK's ten reserve divisions, and to expedite the modernization of all of ROK's front-line forces. Subsequently, between 1966-1970, ROK received large numbers of tanks, artillery, small arms, patrol craft, and other military material.

Aid for operations and maintenance increased significantly in 1969-1970. In 1969, $100 million was requested over and above the approved appropriations to update anti-aircraft systems, patrol boats, and radar. This also authorized a squadron of F-4-E Phantoms, which ROK had requested earlier. [Ref. 8: p. 417]

5. THE THIRD DECADE, 1970-1980

Little change could be noted as the seventies arrived. NK still was essentially reliant on the Soviet Union for military and economic aid. Since 1969, relations between NK and China have remained good, but China has been unable to deliver much aid to NK. Although promises flowed freely between Peking and Pyongyang, material did not.

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2 The International Institute of Strategic Studies (IISS), The Military Balance (London: IISS, 1969), p. 64.

ROK and U.S. relations remained strong in the early 1970's, but became strained in the mid-seventies. Changes in the relationships between the suppliers was an important factor.

NORTH KOREA

NK's relations with the Soviet Union remained critically important during the early and mid-seventies. The Soviets were still NK's major source of arms, and its major trading partner. However, Soviet arms transfers and military assistance brought little increased influence. NK, although dependent on Soviet arms and aid, refused to move from their position of neutrality in the Sino-Soviet dispute. Soviet-North Korean relations, although cool and formal, were still firm, as was emphasized by the renewal of their Mutual Defense Treaty in 1976. Underlying Soviet aid to NK was the concern that renewed violence by Kim would undermine the SALT I agreement and the new-found detente with the United States.

Actual arms transfers to NK during the seventies did little to improve their offensive capabilities. They received 28 SU-7 fighter-bomber aircraft in 1971, and two squadrons of MIG-21's between 1974 and 1978. Only the SU-7 could be considered as improvement, since the MIG-21's were simply replacements for aging aircraft; they added little to the offensive capability. The ground forces were supplied with 50 T-62 tanks in 1975. [Ref. 9: p. 268]

REPUBLIC OF KOREA

Arms transfers to ROK, like those to NK, were mostly defensive in nature during the 1970's. The only real air threat is posed by the 47 F-4-D,E aircraft provided to ROK from 1971-1977. The sale of 60 additional F-4's was approved in 1979, however, these aircraft were not delivered at that time. Offensive capabilities for ROK ground forces have been improved by the transfer of over 500 M-48 tanks which ROK converted to M-48 A-5's.

ROK's defensive capability mushroomed during the seventies. With the addition of 150 F-5E fighter aircraft delivered in th seventies to their previously acquired aircraft which included F-4's, ROK became quite capable of defending itself from an attack. Further reinforcing ROK's defensive capabilities were over 1,500 AIM-9 and AIM-7 advanced air-to-air missiles, the Nike Hercules, and Hawk surface-to-air missiles, and the Vulcan 20mm anti-aircraft system added in the seventies.

6. THE FOURTH DECADE, 1980-1988

The arms race between ROK and NK continues. In spite of domestic unrest, the ROK's economy now has a very healthy trade surplus through export growth. In the fourth decade both ROK and NK have greatly increased their indigenous arms industry capabilities. They want to import high technolodgy arms and develop the skills necessart to upgrade anti-tank and anti-aircraft weapons. At this time they can produce almost all small arms and ammunition for domestic use.

NORTH KOREA

In the fourth decade NK increased their importation of aircraft and missiles. The Soviets continue to be the main supplier to NK during this decade. China transfered 20 F-6 fighter aircraft in 1982, the Soviets supplied 20 MIG-21F in 1983, and 30 MIG-23F in 1984. In 1985 NK increased their aircraft received by 26 MIG-23F in 1986 and 24 in 1986. Included were special ammunition and missiles for the aircraft which were delivered. In 1987 NK requested 3 SU-25 Frogfoot missiles from Soviet Union and got them in 1988. During the 1980's NK developed an extensive arms industry capabilitiy. Now they are seeking high technology arms instead of basic arms and more aircraft from the Soviet Union.

REPUBLIC OF KOREA

With the growing economy ROK increased their military expenditures on arms imports. The U.S. is still the major supplier to the ROK. In 1982, ROK requested Hawk missiles from the United Kingdom. Negotiation has taken place but delivery has not.

Like the NK, ROK also has a great arms industry capability. Thus more emphasis is being placed on increasing their air power and anti-tank power and the number of missiles. ROK has continuously requested more aircraft from the U.S. throughout the 1980's. In 1980, 15 F-5E's Tiger 2 fighters were requested and delivered in 1982. In 1981, 30 F-16C's and 6 F-16D's were ordered from U.S. and lately delivered. Four F-4E Phantom were delivered in 1985 and 24 F-4D Phantomswere again ordered and delivered between 1986-87. (See Appendix B) The ROK Army received its first 200 plus Type-88MBT (locally manufactured and substantially modified M-1 Abrams.) The ROK can now produce Type-88MBT with some U.S.support. [Ref. 10: p. 19] These actions herald a new era for the military arms race on Korean Peninsula.

The arms race between ROK and NK will continue. As time passes both ROK and NK increase their arms industry copabilities and raise their portion of co-production plan with their major allied nations. ROK and NK can produce almost all conventional small arms and ammunitions. Also they can produce some main battle tank and high-technological items. Until now both Koreas still rely on their major allied nations in major arms supplies and production, but when they increase their capability to produce major weapons, the arms race will be faster than before and it will increase the possibility of nuclear war on the Korean Peninsula.

C. ARMS INDUSTRY

Both ROK and NK have been driven by security, economic, and political motives to develop their own arms industries. These reasons have also pushed them to manufacture a growing variety of weapons, both for indigenous use and for export. To date, arms industries in both Koreas are dependent on foreign technology input; however, these inputs have developed an indigenous data base, and increased local manufacturing skills to a point where most systems can be manufactured without relying upon imported parts.

ROK and NK are now manufacturing significant items of military equipment and are looking for an increasing share of the international arms market.

1. North Korean Indigenous Arms Production

NK has a large and well-developed arms production industry. Current production capabilities are shown table 1. (See Table 1). This table is only a "best estimate" of current production capabilities. Actual production is a state secret; however, unclassified sources were combined to establish these figures. The table also includes equipment indigenously produced under license.

NK produces all equipment for its ground forces. They are belived to have the capability of manufacturing 20 T-62 tanks per month. ROK sources say NK may have produced and deployed about 2600 T-62 tanks. NK also produces their own artillery and light infantry weapons, and the ammunition for each.[3] They established a defense

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[3] SIPRI Yearbook 1981. P. 364.

of surface-to-surface missile assembly industry and are now capable of supplying a much wider range of weapons including SCUD missiles.[4]

Table 1. NORTH KOREAN INDIGENOUS ARMS PRODUCTION

ARMY	Artillerytowed	122 mm 130 mm 152 mm
	Self-Propelled	SU-76 SU-100
	Tanks	T-62
	APCS	BTR-40 BTR-60 BTR-152
		K-61 Amphibious Vehicle
	Infantry Weapon	7.62 TT1933 Pistol (Type-68)
		7.62 (AK-47)
		7.62 Light Machingun
	Mortars	120 mm 160 mm 240 mm
	Recoilless Rifles	82 mm 106 mm
	Missiles	SA-2B (From China)
		SAM
		SCUD-B
		AT-3 Sagger ATGMS
	Anti-Tank	40mm RPG-2
	Truck	2.5 Ton GA2-53 4*4
	AAA	37 mm 57 mm 85 mm
	Plus Ammunition For All Basic Weapons	
NAVY	Gun-Boats	Chaho Class Chong Lin Class
	Landing Craft	Nampo Class
		ICM Type LCU Type
	Patrol Boats	Taechong Class
	Frigate	Najin Class
	Submarines	MidgetClass Remeo Class
AIRFORCE	Fighter Aircraft	MIG-21(?)

source: Multiple sources

Most of the indigenously produced equipment in NK is of the older Soviet design. The simple design characteristics of this equipment eliminates most of the tech-

[4] Asian Defense Journal, March, 1989, p. 28.

nological problems involved in arms production. Being simple in design also allows for easy maintenance.

NK has developed a small navy well-suited for its need. In recent years, North Korea has been producing most of its naval vessel's.

NK received permission,to manufacture the MIG-21 under license in 1974. To date, there is no indication that North Korea has been able to master aircraft production. [Ref. 11: p. 147]

NK now has a fully developed weapons industry. It is not sophisticated in the equipment it manufactures (Soviet and Chinese standard bloc items) and there remains a lagging electronics industry to support production of modern fire control and gun laying computers.[5] Despite some of the weaknesses of the arms industry, NK has become increased their arms production and export. Should they decide to disrupt peace on the Korean Peninsula they could supply nearly all their own military arms and ammunition.

2. Republic of Korean indigenous Arms Production

ROK did not enter the arms production industry until the mid-seventies; however, by 1988 they had some million dollars worth of arms exports. The enormous growth in the arms industry was fueled by ROK's highly skilled and educated populace, combined with massive U.S. support. It has allowed ROK to become almost totally self-sufficient in weapons production.

ROK is almost totally self-sufficient in the production of equipment for their ground forces. They manufacture all of their light infantry weapons and towed 105mm and 155mm howitzers. (See Table2)

ROK is still dependent on the U.S. for advanced infantry weapons which require U.S. technical support. With U.S. support, South Korea has steadily increased the quality and quantity of weapons production.

ROK's naval production is one of th fastest growing industries in Korea. ROK has developed a small prototype submarine. This was produced despite U.S. claims that ROK did not need a submarine force. Currently, ROK lacks the technical expertise to enter full-scale production of modern submarines, but the production of the prototype is a major technical break through. Also, procuring the submarine production over U.S. objections shows a growing independence in the ROK arms industry.

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5 Ibid., p. 35.

Table 2. REPUBLIC OF KOREAN INDIGENOUS ARMS PRODUCTION

ARMY	Artillery	105 mm 155 mm
	Tanks	M-48A5 Conversion
		Light Tank Prototype
		K-1 MBT
	APCS	Fiat 6614
	AAA	20mm Vulcan
	Infantry Weapons	M-16 K-1,2
	Mortar	60 mm 81 mm 4.2"
	MRL	M-72 M-203
	Recoilless Rifle	90mm 106mm 157mm
	Plus Ammunition For All Basic Weapons	
NAVY	Fast Patrol Boats	PSMM-5 Class
	Submarines	Small Prototype
AIRFORCE	Fighter Aircraft	F-5E F
	Helicopter	Hughes 500-D
	Trainers	PL-2

source: Multiple sources

ROK and U.S. coproduce the Huges 500D helicopter in-country. They also produce most of the components of the F-5 E/F aircraft indigenously. Only the F-5 engines, and a certain amount of airframe parts are fully coproduced. The U.S. has supplied ROK with full logistical support packages, all production tooling, data, and training and technical assitance. This will greatly improve South Korea's aircraft technology program, and speed up their F-5 indigenous production development. [Ref. 11: pp. 147-148]

One of the significant improvements in the arms industry of ROK is the K-1 Main Battle Tank coproduction with U.S. support. The K-1 is a slightly smaller (7/8th-size) version of the U.S. Army's M-1 Abrams; this is more suited to the Korean Peninsula's hilly terrain. The new MBT, the product of joint U.S.-ROK design efforts, was known as the XK-1 during the prototype stage. Technical assistance in the design and development of the K-1 was furnished by General Dynamics, Land Systems Divi-

sion, the main contractor for the M-1 Abrams. Production of the K-1 began in 1985 and over 200 production vehicles have been delivered to the ROK Army. The South Korean manufacturing giant is producing the K-1 at its tank plant in Chang-won.[6]

Nowadays ROK has cumulated high technology skills for producing arms and has gradually become an arms export nation. This capability has increased their ability to defense themselves from a North Korean's attack.

D. MILITARY SITUATION ON THE KOREAN PENINSULA

The military competition between ROK and NK has continued and both Koreas military expenditures have increased. The two Koreas allocate considerable resources to security: the North Korean provision of some 12% of GDP for defensi in 1988 represents a slight increase in real terms; while ROK allocated just under 5% of GDP in 1987, an increase of nearly 2% in real terms. [Ref. 10: p. 20]

This section will provied an overview of the total military situation of the Korean Peninsula before comparing the tank gap between NK and ROK.

NORTH KOREA

According to the International Institute for Strategic Studies in London, the NK armed forces number approximately 838,000. The NK Army is the central element, numbering 750,000. The army is believed to be organized into 24 infantry divisions of about 11,000 men each, three armored divisions, five mechanized and motorized infantry divisions and two anti-aircraft divisions. The army also has independent brigades and regiments, including seven armored brigades, nine infantry brigades (up to 8,500 men each), 250 artillery batallions and 80 rocket batallions. There is a commando force of over 20 brigades estimated to number up to 100,000 men. [Ref. 12: pp. 126-127]

The Major items of ground weaponry for the army are:

(1) Tanks and assault guns: over 3,500 including 3,000 T-54, T-55, T-62 tanks and the SU-100 assult gun. The T-62 is a main Soviet battle tanks, and U.S. military officials believe the North Korean version of the T-62 is similar to the Soviet model. Pyong-yang now may have well over 500 T-62's.[7]

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6 Asian Defense Journal, Nov. 1987, p. 82.

7 *Korea Herald*, July 30, 1983. General Robert Sennewald, U.S. Commander in Korea, stated that the North Koreans had converted several infantry divisions to "mechanized or truck-mobile status."

(2) Armored personnel carriers and trucks: 1,000 Soviet-designed BTR 40/50/60/152 vehicles. The BTR-50 and BTR-152 have the largest passenger capacity (19-20 riflemen). Both can transport heavy weapons.

(3) Artillery 4,50 guns including towed guns and howitzers from 76mm to 152mm. The 122mm, 130mm, and 152mm guns have a range of between 13 and 17 miles.

(4) Mortars: 11,000 including the 60mm and 82mm mortars, which can be transported by an individual, and the heavier and destructive 120mm and 160mm types, which must be transported by crews or vehicles.

(5) Anti-aircraft guns: 8,000 ranging from 23mm to 100mm towed guns, the ZSU-23 self-propelled gun and the ZSU-57 self-propelled gun.

(6) Multiple rocket launchers: 2,000 including 900 of a North Korean version of the BM-31 122mm rocket launchers with 30 tubes mounted on trucks.

(7) Long range missiles: NK has maintained a force of Soviet model Frog 5 and Frog 7 surface missiles, which are capable of reaching Seoul from North Korean territory. In 1985, NK reportedly began receiving SCUD-B surface to surface missiles from the Soviet Union. The SCUD missiles have a much greater range and could hit targets in the central part of ROK.

(8) Anti-tank weapons: 1,500 B-10 82mm recoilless anti-tank guns plus 45mm, 57mm, 75mm, and 107mm anti-tank guns. The North Korean army acquired the AT-3 Sagger anti-tank missile system. [Ref. 2: p. 256]

The North Korean air force has 53,000 personel and an estimated 700 combat aircraft. Many are old, however, including some 280 MIG-15s and MIG-17s. The backbone of the air force are twelve squadrons of 160 MIG-21s, a Soviet designed aircraft of the 1960s, and 160 MIG-19s, most of which have been provided in recent years by China. The MIG-21 was the Soviet Union's main fighter aircraft in the 1960's but has been replaced by the MIG-23 and MIG-27. It can be used as an interceptor, with air to air missiles, or in a ground attack role with rockets or bombs. It has a combat range of nearly 700 miles.

NK is aquiring MIG-23 aircraft from the Soviet Union. Estimates of the number NK will receive range from 30 to 50. The MIG-23 is primarily an air combat, air defense weapon. NK has acquired at least 80 U.S. Hughes 500-C helicopters through a West German smuggling operation. These are similar to Hughes helicopters in ROK's arsenal and could be used in a ground attack role with rockets, machine guns, or anti-tank missiles; or they could be used to transport troops.

The navy comprises 35,000 personnel and an estimated 20 submarines (Soviet and Chinese models), with torpedo and mine laying capabilities, four frigates, and 350 various light fast-attack and coastal patrol craft with guns, surface to surface missiles, and torpedoes. Most of these craft are 1960's-vintage of Soviet design with Chinese models added. The navy also has over 100 high-speed naval landing craft, which have a transport capacity of 3,000 troops.

NK's reserve forces are based on the concept of an entire populace in a constant state of readiness militarily and ideologically to defend the country and support the regular armed forces. [Ref. 2: p. 257]

A relatively new development are reports that NK has chemical warfare capabilities. ROK's defense minister stated March 1986 that NK has stockpiled 180-270 tons of chemical weapons, including gases. He noted that mortars, field guns, and SCUD missiles could fire chemical agents, including long range delivery.[8]

REPUBLIC OF KOREA

The ROK armed forces of 600,000 are the largest non-communist military body in East Asia. The armed forces are also one of the best trained and equipped. They have had a singular military mission since the end of the Korean War: defeat any new invasion of ROK by the North Koreans.

The ROK army numbered 520,000 in 1988. The army is organized into field armies, corps, divisions, regiments, batallions, and small units in a manner similar to that of the U.S. Army. It has 19 infantry divisions, two mechanized infantry divisions, two anti-aircraft artillery brigades, two surface-to-surface missile brigades, and seven special forces brigades.

The weaponry, equipment, and organization of the ROK army reveal a force oriented to a defensive posture. Artillery and antitank weapons make up the bulk of heavy equipment. Artillery consists mainly of 3,000 towed 105mm howitzers and towed 155mm howitzers. ROK now manufactures these weapons. The 155mm howitzers have a firing range of approximately 15 miles, while the 105mm guns have a range of over seven miles. Other artillery include about 100 M-107, M-109, and M-110 self-propelled guns. The range of these weapons is between ten and twelve miles. Additional firepower comes from about 180 World War II vintage M-18 and M-36 self-propelled antitank guns. [Ref. 12: p. 128]

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8 Radio Seoul, March 20, 1986.

ROK armor is integrated into the infantry with one tank batallion attached to each infantry division. The two mechanized infantry divisions, comprising six tank batallions, is the only mobile attack force. ROK has 1,300 M-47 and M-48 tanks and 200 K-1 tanks (similar to U.S.'s M-1 Abrams). Most of them are equipted with 105mm gun. The 105mm gun on Israeli tanks proved effective against the Soviet-made T-62 tanks during the 1973 Middle East war. ROK coproduced K-1 tanks with assistance from General Dynamics Corporation. Four hundred-fifty M-113 and 250 Fiat 6614 armored personnel carriers provide a degree of mobility for infantry. The M-113 is a standard U.S. army vehicle and has a capacity of 14 infantrymen; the Fiat can carry six. Other key items are 5,300 81mm and 107mm mortars and recoilless launchers (57mm, 75mm, and 106mm).

ROK's air force is built around 330 F-5 interceptors, over 250 of which have added ground attack weaponry. The air force soon will add 36 F-16s, 36 F-5Es, and 32 F-5F fighters. New armament will include the Sidewinder air to air missile and the Maverick air-to-ground missile. [Ref. 2: p. 269]

The navy has eleven destroyers, seven frigates, and nearly 100 coastal patrol craft. It is emphasizing a strengthened coastal craft force, particularly through procurement of fast attack craft armed with surface to surface missiles.

ROK receives support from nearly 43,000 U.S. troops inside the country and by U.S. forces elsewhere in the Western Pacific. The U.S. Second Infantry Division is a key unit in Korea. It numbers 13,900 and is strategically located in the 25 mile corridor separating the capital city of Seoul and the DMZ. The division is heavily armed with artillery, anti-tank weaponry, and tanks.

The United States maintains twelve tactical fighter squadrons and other combat aircraft in the Western Pacific. Four air force squadrons are located in Seoul Korea; three of these (72 aircraft) are composed of F-16 fighters. Another is composed of 24 A-10 close ground support aircraft. Another three squadrons (72 aircraft) of F-15 fighters are on Okinawa, and the U.S. Air Force rotates these in and out of ROK At any time, there are three to five F-15s in ROK[9] Two squadrens of F-16s are at Misawa in Japan.

The quality, morale, and discipline of ROK troops has improved steadily since the Korean War through Korean participation in the Vietnam War to the present. The ed-

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9 "Special Report: U.S. Pacific Air Forces Modernization," *Aviation Week and Space Technology*, February 7, 1983, p. 53.

ucation level and technical sophistication of ROK enlisted personnel has grown. U.S. officers in ROK rate ROK commanders highly in terms of intelligence, professionalism, and ability to command troops in the field. The training level and education level of officers is high. [Ref. 2: p. 269]

III. NUMERICAL AND STATIC COMPARISON OF TANK GAP BETWEEN ROK AND NK

Before the Korean War, high quality Soviet T-34 tanks were transfered to NK in large numbers and played a central role in achieving victory over the ROK in the beginning of the Korean War. Thereafter, tank forces have continued to be seen by NK as a key element in preparation for war on the Korean Peninsula. As a result of the tank' symbolic importance, it is generally assumed that NK retains a substantial lead over ROK in numbers of tanks.

According to recently declassified data from military reports, i.e., *The Military Balance, 1987-1988*, NK outnumbers the ROK in tanks. It is less clear how this numerical advantage translates into an advantage between ROK and NK tank capability. That relationship depends not only on numbers but on the quality of tanks and on other factors.

The anticipated tank battle scenario on the Korean Peninsula is much different from a scenario in Europe. The Korean Peninsula is mostly mountainous terrain except in the western area of the peninsula. Direct battles between tanks will probably not occur in the mountainous areas. Therfore most of the tanks can be used to exploit initial penetrations with mobility and firepower. From this point of view, understanding the organization of armored forces provides a foundation of knowledge before making any comparisons between the two countries.

This chapter provides the organization of armored forces of ROK and NK. It focuses on a numerical comparison of tanks between ROK and NK with and without U.S. support of the ROK. It also provides a comparison from the static point of view. Comparison methods for evaluating the tank gap on the Korean Peninsula care critiqued.

This section will look at what is commonly believed to be the most important single category of equipment currently held by ground forces: the tank. Because this thesis focuses on this single weapon category, we will not attempt to assess other ground forces equipment, such as artillery and other armored vehicles.

A. THE ORGANIZATION OF ARMORED FORCES OF NK AND ROK

1. North Korea's Armored Forces

North Korean offensive doctrines will not differ greatly from those of the Soviet Union, with mixed Chinese concepts included as a result of earlier fighting experience during the Chinese Civil War and the Korean War.

According to an unclassified U.S. Army publication issued in the early-eighties, "tanks are combined with other arms at all echelons. Armor is used to exploit initial penetrations with mobility and fire power. Doctrine, history, and terrain suggest that armored units in the NK will probably be employed piecemeal in support of the infantry."[10]

According to recently declassified data from Asia 1989 Yearbook, NK has one Armed Division, three Mechanized Divisions, twenty-five Infantry Divisions and fifteen Armored Brigade. The fifteen Armored brigade can be considered a division level.

The organization of each armored division contains some 282 main battle tanks (MBTs), consisting of T-54 -55/-62 mediums. Additionally, the unit has 24 light amphibious reconnaissance tanks (either Type-62 or PT-76s), plus 108 infantry-carrying vehicles (APCs). Twelve armored recovery vehicles (based on the T-34 Classes) are also organic to the division. The mechanized infantry division places greater emphasis on infantry and their supporting weapons with 93 medium tanks, 16 light reconnaissance tanks, and 8 recovery vehicles T-34-T Model B[11]

Tanks are also spread among other units, with the basic Army Corps having 31 medium and two light amphibious reconnaissance tanks. These vehicles are part of the assigned infantry division within each corps. There is also an Independent Armored Regiment that normally has a table of equipment (TOE) of 96 medium and 16 light reconnaissance tanks, derived from the three Tank Battalions, 34 medium tanks (three assigned to battalion headquarters) and two light reconnaissance tanks. This independent armored regiment also has an organic Armored Reconnaissance Company, equipped with ten light reconnaissance tanks. The regiment also has four T-34-T Model B recovery tanks (ARV). (See Figure 2 and 3)

The independent armored regiments have been assigned alongside infantry divisions attached to the various Corps organizations. It may well be that NK now has sufficient tanks to upgrade former regiments to brigade strength. Such an armored force

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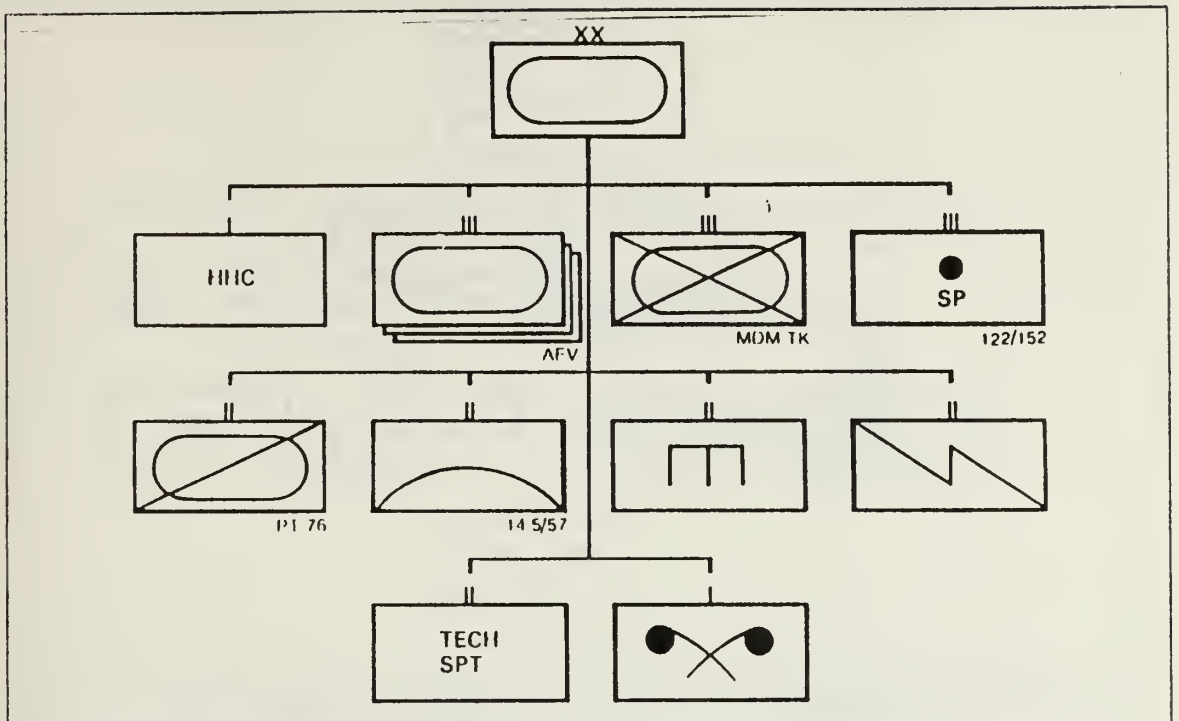
10 Asian Defense, *North Korea's Armored Forces,* June, 1986, p. 58.

11 Ibid.

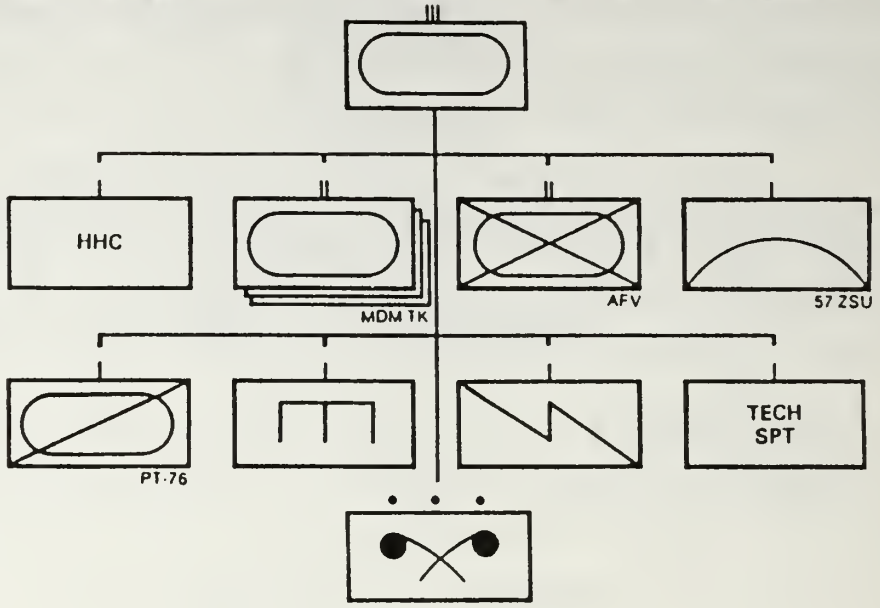


UNIT	PERSONNEL			WEAPONS AND EQUIPMENT																		
	OFFICERS	ENLISTED	TOTAL	RPD RPK / 7.62 LMG	M-37 / 82 MTR	M-43 / 120 MTR	PRG-2 / 40 AT LCHR	? / 122 SP HOW	? / 152 SP HOW	BM-21 / 122 MRL	T-54 55 62 / TANK MOM	PT-76 / TANK LT AMPH	BTR-60 M1967 / APC	ZPU-4 / 12.5 AAA HMG	ZSU / 57 AAA GUN	V-415 / JEEP	2½T UTLY / TRUCK	T-34-T / TANK RTVR	ROKS-3 / FLAMETHROWER		
HHC	23	337	360	3							3					10	40					
MOM TK REGT (3)	41	949	990								93	4				6	12	2				
MECH INF REGT	74	2001	2078	36	27	6	81			6			108	6		4	21		2			
SP ARTY REGT	100	621	721	23				36	12							5	24					
RECON CO	18	252	270	18	9		27					12				5	21					
AAA BN	13	237	250	8			7							12	6	5	12					
ENGR BN	19	307	326	6			10									3	20		6			
SIG BN	17	243	260	8			4									5	27					
TECH SPT CO	8	167	175	6			6									4	16	6				
LOG CO	5	121	126	4			4									1	10					
TOTALS	400	7136	7536	112	36	6	142	36	12	6	282	24	108	18	6	60	227	12	8			

Figure 1. NK's ARMOR DIVISION-STRATEGIC FORCES COMMAND

upgrading has taken place in the last three or four years, that it is likely the new brigades are equipped with domestically-produced T-62 MBTs.[12]

12 Ibid., p. 60.

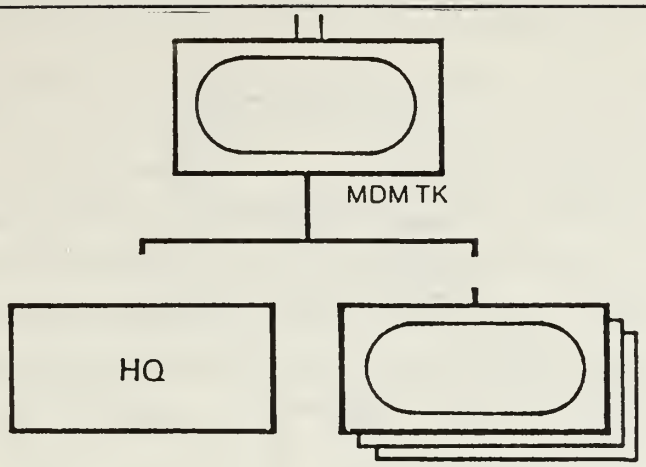


UNIT	PERSONNEL			WEAPONS AND EQUIPMENT																		
	OFFICERS	ENLISTED	TOTAL	T-64 68 / 7 62 PISTOL	AK / 7 62 RIFLE	RPD RPK / 7 62 LMG	M-37 / 82 MTR	RPG-2 7 / 40 AT LCHR	B-10 11 / 82 107 RG	T-54 55 62 / TANK MDM	PT-76 / TANK LT AMPH	BTR-60 M1967 / APV	ZSU / 57 AAA GUN	V-115 / JEEP	2½T UTLY / TRUCK	M-72 / MOTORCYCLE	T-34-T / TANK RTVR	ROKS-3 / FLAMETHROWER			
HHC	27	133	160	27	125	4		4		3		2		2	30							
TK BN 131	22	204	226	22	204					31	2			3	18		1					
MECH INF BN	30	500	530	30	459	11	9	27	6			31		1	13							
AAA BTRY	4	69	73	4	67	2							6	1	12							
ARMD RECON CO	6	90	96	6	75	6		9			10			1	5	8						
ENGR CO	5	71	76	5	63	4		4							7			2				
SIG CO	5	60	65	5	52	1		1						1	8							
TECH SPT CO	5	70	75	5	62	4		4							10		1					
CMD PLT	1	25	26	1	21	2		2							5							
TOTALS	149	1630	1779	149	1536	40	9	51	6	96	16	33	6	15	143	8	4	2				

Figure 2. NK's BASIC CORPS INDEPENDENT ARMOR REGIMENT

2. Republic of Korean's Armored Forces

The terrain of ROK requires that certain "avenues" be followed by armored forces. Despite this tactical disadvantage with regard to armored warfare, it would ap-



UNIT	PERSONNEL			WEAPONS AND EQUIPMENT																				
	OFFICERS	ENLISTED	TOTAL	T-62 PISTOL	AK 7.62 RIFLE	RP-46 7.62 MG	T-54 55 62 TANK MDM	PT-76 TANK LT AMPH	V-415 JEEP	2½T UTLY TRUCK	T-34-1 TANK RTVR													
HQ	7	54	61	7	52	2	1	2	3	9	1													
TK CP (3)	5	50	55	5	50		10			3														
TOTALS	22	204	226	22	202	2	31	2	3	18	1													

Figure 3. NK's BASIC DIVISIONAL TANK BATTALION

pear that the NK is intent upon raising a sufficient armored force to ram its way through combined U.S.-ROK defenses south of the DMZ. Once Seoul has been isolated, then major armored thrusts would be expected to be undertaken down the Western Coast of

the peninsula, as well as some armored thrusts aimed through the central valleys of the country. Despite today's modern weapons on the battlefield and the reequipping of NK and ROK, geography will continue to play a dominant role in any future Korean War.

The Far East Economy Review (FEER) lists in its *Asia 1989 Yearbook*,that the ROK has two mechanized infantry divisions and 19 infantry divisions. Each mechanized infantry division contains three brigades. Each three brigades contains three mechanized infantry battalion, 3 motorized battalions, 3 tank battalions, one reconnaissance battalion and one field artillery brigade. Each infantry division has one tank battalion. Tanks are spread among units. Each tank battalion has almost 50 MBTs, consistion of M-47/M-48A5. Some tank battalion equipped with K-1MBTs. (Type-88, similar to M-1 Abram of U.S. MBT)

The general assessment is that NK has three months of war supplies on hand, before either Chinese or Soviet assistance would be required. While NK's armored forces are only a small part of the over-all military equation between NK and ROK, they may assume much greater importance (and firepower) as an 'exploitation force' once the DMZ is breached.

B. NUMERICAL COMPARISON METHOD

1. Appling Numerical Comparision Method

The first stage in assessing the balance between the tank forces of the two Koreas is to set out the numbers held on both sides. The main source is Asia 1989 Yearbook, published annually by the Far Easten Economic Review.

The quantitative balance of tank forces in Korean Peninsula would depend on the number of tanks with which NK is preparing for an attack and on the number of tanks ROK possesses at that time. Also, the U.S. is expected to respond to NK's preparations for war. Although U.S. officials maintain that the ROK would become aware of the NK's attack, it is generally assumed that the ROK would only have several hours advance notice of NK's attack. For planning purposes, ROK headquarters analysts have assumed 12-24 hours advance notice. This is considered the worst case scenario, by the U.S., for advance notice. Some observers worry that a 12-24 hours may be an optimistic assumption. Of course, ROK will respond more promptly to warning.

According to the recently declassified data from military reports, NK has a significant advantage in numbers of tanks. (See Table 3) Without U.S. support the ROK has 1500 tanks and NK has 3475 tanks. Consequently NK enjoy 2.32:1 advantage over

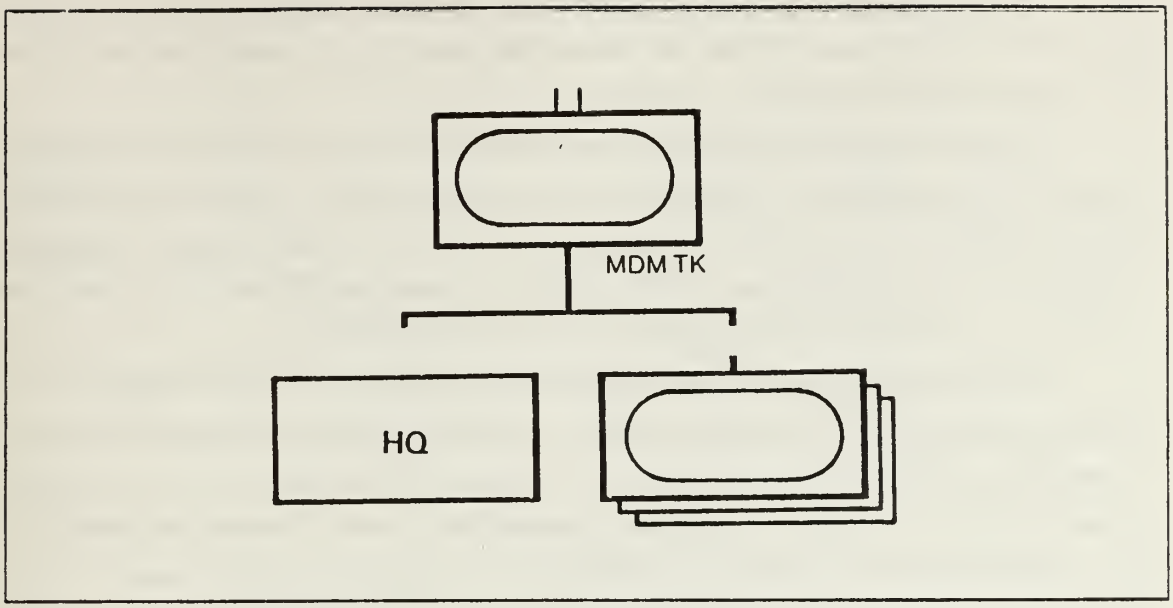


Figure 4. ROK's BASIC DIVISIONAL TANK BATTALION

the ROK in number of tanks. Table 3 shows how many of each model the two nations currently possess.

Table 3. COMPARISON OF ROK AND NK TANKS

Item	North Korea			ROK		
	Type	Number of Tank	Combat Weight metric tonnage	Type	Number of Tank	Combat Weight metric tonnage
MBT	T-34	3000	32	K-1	200(+)	55
	T-54		36	M-47	350	47
	T-55			M-48A5	950	48
Light Tank	Type-62,63	300				
	Type-59	175				
Total		3475	35.3 (average)		1500	49 (average)

Source: Far East Economy Review, *Asia 1989 Yearbook*, pp. 149-153.

The security of the ROK is supported by the Mutual Defense Treaty which it signed with the USA in 1953, and by the nuclear-capable U.S. deterrent forces which are stationed near the DMZ which seperates it from NK.

The ROK and United States Forces Korea (USFK) are closely integrated under an organization called the Combined Forces Command (CFC). Formed in November 1978, the CFC's stated objective is "To deter hostile acts of external aggression against the ROK by a combined military effort of the USA and the ROK and, in the event deterrence fails, defeat an external armed attack against the ROK."[13]

USAF ground forces are grouped under the Eighth United Stated Army (EUSA) which was the core military force with in the United Nations Command during the Korean War. EUSA's principal combat unit is the 2nd Infantry Division. This division is heavily armed with artillery, anti-tank weaponry and tanks. Within 2nd Infantry Division the 1st Brigade comprises two battalions of armor with M60A3 tanks and one mechanized infantry battalion. The number of MBTs in the USAF are 150 M60A3 tanks. When these tanks are added to the ROK's number of tanks the ratio between NK and U.S.-ROK tank gap decreases to 2.1:1. Although the U.S. M60A3 tanks have a high warfare capability and quality it reduced the gap only a small amount from a numerical standpoint.

Outside the ROK, two thirds of the U.S. Third Marine Division is on Okinawa. The 25th Infantry Division and the remaining one third of the Marine Division, both located in Hawaii, back up units in the Western Pacific. The U.S. prepared 1,200 reinforcement tanks to support any conflict as soon as possible. [Ref. 2: p. 258] When these tanks support the ROK the tank gap ratio become more balanced. At this point USAF plays a greater role in maintaining peace on the Korean Peninsula.

A longer conflict with limited outside reinforcement would require a more mobile ROK army for the purpose of elastic defense and counter-offensive operations. Steps to enhance these capabilities could require a 50 to 100 percent increase in the number of tanks in order to form two or three armored or additional mechanized divisions as a strategic reserve.

2. Qualitative Comparison of the Tank on the Numerical Comparison Gap

The numerical comparison method is totally dependent on the number of tanks possessed by NK and ROK. The tanks of both NK and the ROK consist of a range of

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13 International Defense Review, Vol. 19, 1986, p. 193.

different models. Some models are new, some have been upgraded with the latest technology,some were designed as early as the 1940s and some are likely to be of little use in a modern battle. ROK's most powerful tank is the K-1 MBT (similar to the Leopard 2 and the M-1 Abram of U.S. tank), which were transfered to the ROK from the U.S. in 1988. K-1 is equipped with the latest available technology, which remains significantly ahead of that incorporated in the most modern Soviet tanks, the T-64, T-72 and T-80. NK's latest tanks are the T-62 which have less capability than T-64. Therefore, the ROK possesses some tanks that are more capable than NK's.

ROK has followed a policy of carrying-out a major upgrade of its M-47, M-48 tanks to ensure that, although the bodies of these tanks are 20 or more years old, the technology is almost comparable to that on its most modern tanks. As a consequence, the quality gap between old and new-generation models, although it exists, is relatively small. In contrast, older models of NK tanks,-the T-34, T-54, T-55 and T-62, have not been significantly upgraded, and are thus falling further and further behind the ROK tanks of comparable age, such as the M-48. [Ref. 13 : p. 26]

The main reason the earlier models of NK tanks cannot be upgraded significantly at a tolerably low cost is that their original design emphasized cheap mass production and low weight at the expense of quality and adaptability. This choice was not an arbitrary one. Rather, it was a reflection of the relative strengths and weaknesses of NK's industry: technological backwardness combined with a considerable capacity for large-scale production.

One of the most telling indicators of this choice is the relatively low weight of NK tanks. Today the average NK tank weights only 35.3 metric tons compared with 49 metric tons for the ROK. (See Table 3) While the NK has 2.32:1 lead in numbers of tanks, it has a lead of only 1.66:1 in total tank tonnage. When the U.S. M60A3 is added to the ROK tank forces, NK only has lead of 1.5:1 in total tank tonnage.

One could debate at length whether weight would be a better indicator of the relative capabilities of the two sides than a raw number count. At this stage, however, it seems more fruitful to examine in detail what is known about the fighting quality of both side's tanks. This thesis looks at the four capabilities which are of greatest importance in determining tank quality; observation, firepower, mobility and armor protection.

OSERVATION

In order to perform effectively, tank crews must be able to see what is happening. It is widely acknowledged that the earlier Soviet tank models (T-54, T-55 and T-62)

are far inferior to any older 1950 U.S. tank mades in the all round orientation capability which they give the crew, especially the commander. Soviet tank models have fewer and smaller viewing points on commanders cupolas, thus commanders have to stick their heads out more often to observe their surroundings. The more modern ROK tanks (M-48A5 and K-1MBT) are equipped with high performance thermal imaging, which provides not only near-perfect nightvision, but is also useful during the day in the "fog of battle." (See Appendix C) This would give a major advantage to a ROK tank commander, particularly at night, for he would be able to see his opponent trying to see him, but not vice versa. [Ref. 13: p. 29]

FIREPOWER

In order to be effective, tanks need the capability to destroy targets as quickly and accurately as possible, which is a function of both weapons and ammunition and of sights and fire control. In the ROK the most common gun now in service in tanks (M-48A3, K-1MBT) is the British L7 (rifled) 105mm. The L7 compares favorably with the 100mm D10T rifled gun with which the older NK T-54s are equipped.[14] The L7 packs a harder punch, with a muzzle velocity for its fastest round of 1,525 meters per second, compared with the D10T's 1,415 meters per second. It also derives considerable advantage from its greater accuracy of fire.[15]

ROK tanks, in addition to possessing higher quality guns, also on average carry more ammunition. The M-48A5, for example, carries 62 rounds respectively, compared with only 43 and 40 rounds for the T-55 and T-62. This augments the ROK tank's greater staying power on the battlefields. On NK tanks, the commander's and gunner's sights used in targeting generally exhibit a low level of sophistication. Most of the NK's T-34, T-54, T-55 and T-62 tanks still have only the inadequate base-on-target system. By comparison, because of the U.S.'s technological lead over the Soviet Union throughout the 1950s and 1960s, virtually all of ROK tanks now in service have either

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14 The Chinese, who have built the D10T under license, are no longer satisfied with its performance. They have now integrated a derivative of the L7 into their most recent tank design. Bob Furlong, "ASIANDEX, Part I: China launches defense export drive." *International Defense Review,* Vol. 20, No. 1 (1987), pp. 23-27. Other information from "Battle Tanks Supplement," PP. 43-87.

15 An old Armor Piercing Discarding Sabot round from an L7 gun used on an M60 reaches a velocity of 1,426 meters per second. "Battle Tanks Supplement," p. 64; the new Israeli-designed Armor Piercing Fin-Stabilized Discarding Sabot round used in the West German Army, or the very similar round used by the U.S. Army, reaches 1,525 meters per second. Von Senger und Etterlin, *Tanks of the World,* p. 731.

a base-on-own-vehicle optical system or the modern laser system.[16] In order to give accurate instructions to the gun, tanks also need to be able to integrate range data quickly with other data (temperature of ammunition, wind speed and direction, air density and humidity, ammunition type, etc). NK's tanks are not equipped with ballistic computers to integrate range data, however, ROK's K-1 MBT are equipped with ballistic computers. [Ref. 13: pp. 29-32]

MOBILITY

Tanks require tactical mobility in order to gain advantageous firing positions rapidly and dodge enemy fire. They also require operational marches in a wide area to mass at the right spot, at the right time. Several indicators of tactical mobility, i.e., mobility during battle, strongly suggest that the average NK tanks will have less acceleration and flexibility than its ROK counterpart and will find it more difficult to negotiate rocky and hilly terrain during battle.

First, the power/weight ratio is crucial in derterminining both speed and acceleration. As table 4 shows, the power/weight ratio of ROK-U.S. appears to have established a clear lead over the NK model's.

Table 4. SELECTED TANK MODELS BY POWER, WEIGHT, AND POWER/WEIGHT RATIO

Country	Type	Automotive power (kw)*	Weigh (metric tonnes)	Power Weight ratio (kw per ton)
ROK	M-48A5	5720	48	11.9
	K-1	1,100	55	20.0
U.S.	M60A3	572	51	11.2
NK	T-54, 55	427	36	11.9
	T-62	427	38	11.2

* Figures for automotive power taken from von Senger und Etterlin, *Tanks of the World (1983 ed.)*, pp. 724-730. Source: International Security Vol. 13.

16 A few older series M-47 tanks may still use a range-finding heavy machine gun

Second, the standard of transmission and steering determines to a large extent how quickly and flexibly the tank driver can respond to changing battle and terrain conditions. Therefore they can play a significant role in tank survivability and optimal fire allocation. Here NK tanks are at considerable disadvantage, with their typical gearbox and steering mechanism representing technology that can only be described as ancient; manually-handled gearbox, mostly only partially synchronized, plus clutch and brake for steering. By comparison, the ROK standard includes automatic gearboxes and hydrostatic/hydrodynamic steering; which increases automotive flexibility considerably.

Finally, the degree of road wheel travel, which is a function of suspension type and spring elasticity, affects terrain negotiation. For both the NK's T-54 and the T-62, overall (up and down) road wheel travel is around 160mm. For ROK and U.S.'s M-48 and M-60A3 is 320mm, while the K-1 has a road wheel travel of just under 500mm.

NK's military doctrine puts more emphasis on operational mobility than on tactical quality of battle tanks: that NK philosoply dictates production of large numbers of relatively inexpensive tanks, which can then be swiftly concentrated in order to gain overwhelming local superiority along vital axes of attack. If this superiority is achieved, it is argued, the relatively poor quality of individual NK tank may matter less than their numbers. Analysist say the real-ability of Soviet model tanks are much less than U.S. model. [Ref. 13: p. 33]

ARMOR PROTECTION

Tanks require some capability to move and fight under fire without immediately seeking safety in evasive movements or protective terrain. Therefore all tanks were fitted, until the late 1960s, with armor made from specially hardened steel ("rolled homogenous armor," or RHA). Specific weights of armor plate did not vary significantly between the NK and ROK. Protection against attack with kinetic energy rounds was a function mainly of the thickness of the armor applied.

From the late 1960s on, however, there was a rapid development of modern "composite armor" by a British Royal Ordnance team led by Richard Simpkin. The "recipe" has been a closely guarded secret, but composite armor usually consists of layers of plates of different types of very hard steel and other metals (e.g., aluminum) sandwiched with ceramics, glass or man-made fibres. Compared with traditional RHA, composite armor is estimated to have up to 1.5 times as much protection from kinetic energy rounds and between 2 and 3 times as much protection from shaped-charge am-

munition. All K-1MBT armor protection is composite armor fitted. This means K-1 MBT have increased survivability on the battlefields.

The Soviets have prepared their T-64B, T-72M1, and T-80 tanks for fitting with "reactive armor." But NK's tanks does not fitting with reactive armor. Reactive armor is -layer of lightweigh explosive elements that look like bricks. It is designed to neutralize the effect of the small caliber shaped-charge warheads typical of many lightweight anti-tank weapons. When a shaped charge hits a panel of reactive armor, the panel explodes, disrupting the formation of the high-pressure jet of metal and gases which shaped charges use to penetrate armor.

Reactive armor, however, provides Soviet model tanks with only limited protection against U.S. tanks. U.S. tanks do carry shaped charges and fragmentation rounds for use against other targets, such as infantry and light armor. But their main anti-tank weapon is the kinetic energy round, which relies on its high velocity -over a mile per second- to penetrate enemy armor. Compared with shaped charges, the effectiveness of these rounds is likely to be much less affected by Soviet reactive armor.

The Soviet disadvantage in the technology of armor protection is greatly compounded by the upper weigh limit of its tank designs, a result of weak engine technology. Even if the Soviet Union equals Western countries and the U.S. in armor technology, they would be unable to apply that technology effectively because of their small tank size. As a result, almost all T-54, T-55 and T-62 tanks in service are fitted with neither composite nor reactive armor. In this standpoint ROK tanks have increased reliability and survivability on the battlefields. [Ref. 13: p. 39]

OTHER FACTORS IN TANK PERFORMANCE

Other factors can affect a tank's performance, although to a lesser degree. The factors are also likely to vary in influence according to the context in which the tanks are to be used. Soviet tank models are, in general, more difficult to live and fight in than the relatively more spacious U.S. models. U.S.-ROK tanks have more capability in night battle than NK tank. Also, U.S-ROK tanks have an automatic range finder and use Ballistic computer to control fire. NK's tanks do not have these systems. (See Appendix C) Some U.S.-ROK tanks have the capability to shoot while in moving with high accuracy.

These kind of quality terms should be considered whenever making a comparison between the two countries. The numerical comparison results of the tank gap between ROK and NK should be decreased due to the quality terms. In recent years,

though it appears that the tank gap between NK and ROK tanks has been widening still further.

C. STATIC COMPARISON

Rather than rely on simple counts, a static comparison method can be used that not only reflects the quantity of weapons but also their quality and the time lines of tank arrival in the battle areas. Static comparison methods consider only the total of forces available to each side at a given time. They do not attempt to account for the progress of fighting or combat losses on either side. Such methods can, however, be used to examine how the balance changes as mobilization progresses and more forces become available to each side.

The static method used in this thesis is based on weapon effectiveness indices (WEI) and weighted unit values (WUV) developed by the U.S. Army. The WEI/WUV method avoids, as much as possible, subjective assumptions concerning the conduct of war. This technique first evaluates and ranks each type of ground weapon--such as a tank, personnel carrier, or howitzer-- relative to other weapons of the same type, to arrive at an effectiveness index for each weapon. Weapons are typically evaluated on the basis of their firepower, mobility and ability to survive an enemy attack. Thus, various types of tanks receive WEI scores and are then ranked against a norm, which for tanks is the U.S. M60A1. For example, the M60A1, as the norm receives a WEI of 1.00; the M60A3, an upgraded version of the M60A1, an index of 1.11 based on its improved fire control system and power train; and the M1A1 Abram, the newest U.S. tank a WEI of 1.34 because of its overall superiority. The Soviet version T-62 tank, when measured against the category standard of a U.S. M60A1 tank with a WEI of 1.00, has a WEI of 1.03. [Ref. 14: pp. 13-14]

This thesis compares only NK and ROK tanks. As assumed earlythe Capter One, both the Koreas tank's capabilities are the same model of their allied nations tank's capabilities. From this point of view, ROK's newest model of tank (K-1 MBT) has a WEI score of 1.34 like the M1A1 Abram of U.S. tank. According to Mako's *U.S. Ground Force and the Defense of Centural Europe,* published by the Brooking Institution, 1983, the Soviet T-55 tank's WEI score is 0.89 and the average value for a given force of T-54, T-55, T-62, T-64 and T-72 tanks is a WEI score of 1.02. [Ref. 15: PP. 114-123] NK does not have any T-64 and T-72 that are updated beyond the T-62. Therefore, NK's average WEI score should be below than 1.00. ROK's K-1 MBT have 1.34 WEI score. ROK's

M-47 and M-48A5 tanks are older model of the U.S. M60A1, so these two tanks have an average WEI score below 1.00. For comparison purposes let the NK's average WEI score of T-34, T-54, T-55, T-62 equal 1.00 and the ROK's average WEI score for M-47 and M-48A5 equal 1.00. From this, the results in Table 5 are derived.

Table 5. RELATIVE VALUE OF TANKS ON THE KOREAN PENINSULA

Country	Types of Tank	Number of Tank	Weapon Effectiveness Index	Category Weigh	Weight Value
NK	T-34, T-54, T-55, T-62, Type-62,63, Type-59	3475	1.00	64.00 (Offensive)	222,400
ROK	K-1	200	1.34	55.00 (Defensive)	14,700
	M-47	350	1.00	55.00 (Defensive)	71,500
	M-48A5	950			
U.S.	M60A3	150	1.11	55.00 (Defensive)	9,157.5

Source: William P. Mako, *U.S. Ground Forces and Defense of Centural Europe,* Washington, D.C., 1983, pp. 113-125.

Relying on the table, NK's WUV is 222,400 and the ROK's WUV is 86,240 and the tank gap ratio between NK and ROK becomes 2.58:1. When U.S. tanks added to ROK's tanks the ratio decreased to 2.33:1.

When the static comparison model is evaluated with the numerical comparison model, the static comparison model indicates a greater imbalance in the tank gap between NK and ROK. That is, the NK scores a higher category weight (64.00) than ROK (55.00) because assumed that NK will break the peace.

D. LIMITATIONS OF THE COMPARISON METHODS

Like any analysis that attempts to quantify the many aspects that contribute to military capability, the WEI/WUV approach suffers from several important drawbacks. One obvious drawback is the lack of more recent WEIs for the individual tanks currently

in NK and ROK. This analysis, however, does not propose to be a precise evaluation of either NK's and ROK's tanks capability.

Numerical and static comparisons ignore other decisive variables, such as strategy, maneuver, terrain, and combat attrition, that determine the conduct of war. Such comparisons, therefore, are more valuable for assessing the relative standing of opposing forces before a war starts and are more useful for evaluating deterrence capability rather than war-fighting ability.

These analytic methods also ignore many attributes of a military unit--such as quality and training of personnel, support equipment, logistic capability, and the interplay of various weapons--that can determine the outcome of a particular battle. Despite their importance, however, these factors often do not lend themselves to easy translation into numerical values. Such comparisons are obviously subjective and not as amendable to quantification as tank range, accuracy, or speed. This is the case, too, with resupply and maintenance capability. Everyone knows that efficient ammunition and fuel resupply is necessary for the effective operation of a combat unit, but very few analysts have suggested ways to quantify such a capability.

Also, the WEI WUV method assumes that the added benefit of additional weapons is linear--that is, more weapons of any kind continue to provide the same additional capability as the first such weapon. This assumption is called "constant marginal utility" in economic jargon and ignores the fact that, beyond a certain point, additional weapons of one kind might be redundant and therefore of no added utility. For this reason, WEI/WUV scored should not be used by themselves to determine the optimal mix of weapons in a division.

Together these various limitations suggest that assessments of the conventional balance using numerical comparison and WEI/WUV scores cannot predict the outcome of a confrontation between NK and ROK. WEI/WUV scores are, however, useful tools in investigating the effects of various assumptions on today's conventional valance. [Ref. 14: pp. 16-18]

Empirically, numerical superiority, at least in troop strength, is neither a necessary nor sufficient condition for battlefield victory. Notably, smaller forces won several times. The wisdom about this balance is recognizing that war outcomes are sensitive to scores of factors, rather than the handful regularitly discussed. Assessment should consider a vast range of plausible scenarios, where scenario is constructed broadly to mean a set of assumptions about, for example, political-military context, warning times, mobilization times, alliances, operational strategies, force effectiveness, sheer quality of

leaders and their troops for constant equipment, and even the 'laws' of combat that determine rates of advance and attrition.

Static quantitative analysis is by no means useless, but its utility is limited. The numeric primary value is that is establishes the basic parameters within which a more comprehensive assessment of the tank gap in Korean Peninsula can be conducted. In otherwards, the straightforward accounting of the forces of each side is where analysis of the conventional balance should begin, not end.[17]

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17 Carl Levin, "Realistically Assessing the Conventional Military Balance in Europe", *Beyond the Bean Count*, Second Edition July, 1988, pp. 5-6.

IV. DYNAMIC ANALYSIS OF TANK GAP BETWEEN THE ROK AND NK

Conventional military balance on the Korean Peninsula dominates ROK defense planning and accounts for the bulk of ROK military spending. Certainly, this balance should be assessed as rigorously as possible. Although figured out, the numeric and static assessment of the tank gap between NK and the ROK in the previous chapter does not account for the progress of fighting or attrition rate on each side.

Since warfare is a dynamic process, however, one in which numerous factors interact overtime, the prospects for conventional defense cannot accurately be measured by a mere numeric or static comparison of opposing weapon inventories. In the wartime situation everything will not uncertain and nobody can tell which part can win. However, a favorable outcome can be anticipated by using dynamic analysis. Therefore, a dynamic analysis is essential.

A close account of each side's prebattle forces (for example, tanks) is necessary to any assessment, but accounting alone is not sufficient in a dynamic situation. Soldiers, analysts, and students of history have long recognized that military outcomes depend upon operational factors, such as warning, readiness, geography, tactics, coordination, logistics, combat technology, and troop skill, none of which can be reflected in the raw numerical comparisons that seem to dominate the debate. Indeed, the static and numeric comparison of peacetime weapon inventories can be dangerously misleading if taken as authoritative evidence of an inability to achieve national wartime goals: the assumption that numerical inequality implies military inadequacy can lead to misallocations of resources and to the inflation (or deflation) of enemy capabilities, either of which could prove destabilizing in crisis and escalatory in war.

If these errors are to be avoided and reasoned judgements made about the material adequacy of one's forces, it is critical that one's analytical methods relate inputs (prebattle force structures) to outputs (performance in the execution of wartime missions) in a plausible way, explicitly representing the dominant variables and their interaction over time. [Ref. 16: p. 1]

This chapter presents Lanchester's model as a dynamic analysis model and examines the dynamic situation of the tank gap between NK and the ROK. The Lanchester model will be described in detail and its limitations when applied to measurement of the

tank gap between NK and the ROK. The Epstein model is also described without mathematical equations.

A. DYNAMIC MODEL

One of the pioneers in the development of such dynamic methods was Frederik William Lanchester. Born in 1868, the eclectic English engineer made contributions to such diverse fields as automotive design, fiscal policy, and before his death in 1946, to the theory of aerodynamics. His reason for conducting an analysis of military combat was to explain the principle of concentration of firepower. Using his model one can study and analyze mathematically the process of combat attrition. Others have subsequently expanded and developed Lanchester's equations into what has become known as Lanchester-Type model of combat. Essentially, a Lanchester-Type model of combat is a set of differential equations which describe mathematically the interactions of opposing combat forces. When this set of equations is solved for force levels as a function of time, the conditions necessary for one force to win (given a definition of winning, such as driving the opposing force level to zero) may be obtained.

The usefulness of a Lanchester-Type model is that such a model can give some insight into the over-all dynamics of a combat situation. Using a Lanchester model, one may learn, for example, which of a set of possible tactics appear to be "better" in a given situation. "Better" could be thought of in terms of winning a battle in a shorter period of time, or winning a battle while suffering less casualties. One may also learn why a particular tactic is successful, by studying the mathematical formulation of the combat dynamics. Lanchester is best remembered for his equations of war, appropriately dubbed the Lanchester equations. Lanchester's laws occupy a prominent place in the study of conventional warfare: they lie at the heart of many models of conventional combat, they appear to shed light on the quantity versus quality debate, and they provide a simple paradigm for understanding the dynamics of combat.

1. Lanchester Model

The Lanchester equations have for decades dominated the dynamic assessment of conventional land balances. Lanchester described the attrition of each side in a two-sided struggle by means of a system of ordinary differential equations.[18] Begining with

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18 He described this in his book *Aircraft in Warfare; The Dawn of the Fourth Arm,* Constable and Co., London, 1916.

three basic assumptions, he postulated two types of attrition: the linear law and the square law. The assumptions common to both theories were:

- Two military forces (red and blue) are opposing each other. On each side, every soldier is armed with the same weapon. The attrition rate at which a single weapon of one kills units of the other side may not be the same for each side.
- Every weapon on each side can take under fire all weapons of the opposing side.
- The attrition rates for each side are known and do not change for the duration of the engagement.

The original Lanchester's linear law results under the circumstances where each side is ignorant of the exact location of its opposition but does have knowledge of the general area occupied (area fire). Furthermore, as units of each side are destroyed, the survivors distribute their fire uniformly over the area occupied by the surviving opponents. Lanchester's original square law is applicable in the situation where each unit of both sides knows the precise location of all surviving units of its enemy, so that as opponents are eliminated, fire is immediately shifted to and uniformly distributed over all surviving units (aimed fire).

The U.S. Army, the Joint Chiefs of Staff, and analytical directorates within the Office of the Secretary of Defense employ Lanchester-based models to assess theater balances and to aid in the selection of weapon systems. Theater-level combat modeling conducted under contract to the Pentagon is also dominated by Lanchester theory and its extentions. Unlike static and numerical comparisons, the Lanchester equations recognize some of warfare's operational dimensions and allow one to estimate such things as the winner and loser, the daily number of survivors on each side, and the duration of the war.

Two of Lanchester's results have become known as "laws": the square law and the linear law. These two laws form the basis for most applications of the Lanchester equations. Crudely put, the square law states that the measure of combat power is a force's effectiveness times the square of its numerical size. If two forces are equal by this measure, then neither side will win. Thus, the square law makes the outcome of combat more sensitive to force size, the squared term, than effectiveness. It is for this reason that the law has become so popular in the quantity-quality debate.

Lanchester's linear law is perhaps better known, even though Lanchester hypothesized that it primarily applied to ancient combat and to the case of indirect fire. Unlike the square law, the linear law gives equal weight to force size and effectiveness. [Ref. 17: p. 91]

The literature on original Lanchester's law and equations has been very technical and mathematical, creating a communications gap between professional modelers, the consumers of model results, and academic analysts interested in conventional combat modeling. Therefore, this section provides a nonmathematical introduction to Lanchester's equations based on the exploration of John W. R. Lepingwell published in *International Security,* Summer 1987.[19]

a. The Square Law

Lanchester suggested that it is the nature of modern warfare that the instantaneous casualty rate on each side be proportional to the current numerical strength of the opposition, provided that the combat situation be such that the numerically superior side is able to bring its full superiority to bear on the opposition. Lanchester was led to derive the square law by observing that modern weapons allow the concentration of fire. This observation provides the basic assumptions underlying the square law: fire is directed, both sides are able to aim and concentrate their fire upon selected targets, and fire is distributed evenly over targets. Targets must be visible and targetable, and the consequences of fire must be determinable so that after a target is disabled, fire will be immediately shifted to a new target.[20] If forces are lined up along a wide front, concentration of fire is limited by the range of weapons, but the square law still holds in this case if both forces are deployed with uniform density along the sector of the front being modeled.[21]

The square law can be easily derived from the above assumptions. Assume two forces (Red and Blue) facing each other in the open, armed with rifles, able to aim their fire at each other, and able to shift their fire to a new target when a target is disabled. In a given interval of time, each member of Red's force chooses a target, fires at it, and has a certain probability of hitting and disabling the target.[22] It will refer to the

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19 John W. R. Lepingwell, "The Laws of Combat Lanchester Reexamined," *International Security,* Summer 1987.

20 This assumption may seem obvious, but in war the determination of the effects of fire is often quite difficult.

21 If the forces are lined up with uniform density along the front, one can cut a number of narrow strips perpendicular to the front, and within each of these strips, concentration of fire should be possible. See H. K. Weiss, "Lanchester-Type Models of Warfare," in M. Davies, R.T. Eddison, and T. Page, eds., *International Conference on Operational Research* (Baltimore, Md.: Operations Research Society of America, 1957), p. 81.

22 There is also an implicit assumption that target acquisition time is small and that targets

combined probability of hitting and disabling the target as the probability of kill.[23] During the time interval, it is assumed that each Red rifleman fires several rounds, and if he disables his designated target, he shifts his fire to a new one. The rate of fire times the probability of kill of each shot is the *effectiveness* of the force.[24] Mutiplying the number of Red riflemen firing by their effectiveness gives the expected number of Blue riflemen disabled in the time interval. Thus the rate of loss of Blue is the product of the number of Red riflemen and their effectiveness.

If the number of Red riflemen is doubled, while holding the number of Blue riflemen constant, Red will be able to fire twice as many bullets at Blue as before; they can concentrate their fire on the Blue riflemen. Since Red's volume of fire has doubled, Blue's rate of loss will double.[25] If each side is composed of homogeneous forces with the same type of weapon and vulnerability, and both sides are using directed fire, it can be obtained the square law by expressing the logic in mathematical form. Using the notation:

R: number of men on Red's side

r: the effectiveness of Red's fire on Blue

B: number of men on Blue's side

b: the effectiveness of Blue's fire on Red

We may then represent the rate of loss of the forces:

$$\frac{dB}{dt} = -rR$$

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are always available to be fired upon. Thus the rate-determining factors is the rate of fire, rather than the rate of appearance of targets. If the target acquisition time is inversely proportional to the number of enemy targets and is the rate-determining factors in the process, then the linear law is obtained. See Taylor, *Lanchester Models of Warfare,* Vol. 1, pp. 92,163.

23 The probabilities of hitting and disabling the target are conceptually different, but in Lanchester's derivation, they are combined into one probability. This probability is referred to as the probability of kill in keeping with the common usage of the term.

24 Effectiveness is called the attrition-rate coefficient by Taylor. Although the latter term is more accurate, the term "effectiveness" will be used for consistency with Lanchester.

25 The objection may be raised that there is no reason to believe that this doubling is correct; the relation between number of shots fired and rate of loss may well be nonlinear. This objection may be valid, in presenting the basic forms of the Lanchester equations, rather than a different model.

$$\frac{dR}{dt} = -bB$$

where dB/dt is the rate of change of the Blue force over time, and dR/dt is the rate of change of the Red force over time. The parameters R and B are refered to as *force levels,* since they represent numbers of riflemen, tanks, or other forces. The above equations state that in a very short period of time, the rate of loss of one force is proportional to the number and effectiveness of the opposing force. Solving these two equations for the case of equally matched forces gives the square law equality condition:

$$rR^2(0) = bB^2(0)$$

This equation states that two forces are equal when the products of the square of their force levels and their effectiveness are equal.[26] Equal in this sense means that both forces will be completely destroyed if the battle is allowed to continue until completion.[27] The square law indicates that the appropriate measure of a force's military capability is the force level squared times its effectiveness, which Lanchester termed the *fighting strength* of the force. If a force's size is doubled, its fighting strength would be increased by a factor of four, while if its effectiveness were doubled, the fighting strength would only double. The square law therefore indicates that the outcome of combat is more sensitive to changes in numbers than to changes in weapons effectiveness. This is often taken to mean that weapons quantity counts more than quality, hence the invocation of the square law in the quantity-quality debate. This square law is much more favorable to NK than to the ROK. Because, As discussed in Chapter III, NK possess more tanks

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26 The above form of the equation is obtained by setting the rate of loss equations equal and integrating with respect to the two force levels, giving the general solution:

$$r[R^2(t) - R^2(0)] = b[B^2(t) - B^2(0)],$$

with R(t) and B(t) set to zero.

27 In theory, the combat between equal forces continues for an infinite length of time since the equations and variables are continuous, but in practice, targets are discrete and the battle will end at some point. The forms of the Lanchester equations presented here assume that combat will be continued until the end. Breakpoints can be incorporated into the equations, allowing one to model forces that do not fight to the finish and that might "break" at different force levels. The choice of these breakpoints may be critical to the outcome of a model. See Taylor, *Lanchester Models of Warfare,* Vol. I, pp. 123-140, 234-368; and Rovert L. Helmbold, *Decision in Battle: Breakpoint Hypotheses and Engagement Termination Date,* R-772-PR (Santa Monica, Calif.: Rand Corporation, 1971).

than the ROK so the tank gap should be greater even though NK tank's capacity is inferior than U.S.-ROK tanks.

The square law captures an important characteristic of modern warfare in that it incorporates the advantages of concentration and directed fire.[28] This fits in well with military thought on the utility of concentration and makes the square law very appealing for modeling combat.[29] Concentration of fire leads to two important characteristics of the square law. First, is the differential casualty ratio. This is defined as the ratio of the loss rate of Blue and Red forces ($dB/dR = rR/bB$) and varies inversely with the force ratio. Because the larger force can concentrate its fire on the smaller force, if the larger force adds more numbers, its losses will decline because it can destroy the enemy even more rapidly. The more the winning force outnumbers the losing force, the greater will be the loss rate of the losing force, while the winner's loss rate will stay the same. The battle will, therefore, last a shorter period of time, and the winner will suffer fewer casualities.

The behavior of the differential casualty ratio points out the importance of concentration and supports the military dictum of never divide one's force. As Lanchester recognized, it is always preferable to outnumber an opponent by as much as possible and to engage the enemy with the full force simultaneously rather than sequentially.

As an example of the above, let us assume an tank troop of 500 giving battle in turn to two tank troops of 400 and 300 respectively, equally well armed (same effectiveness); then the strengths are equal since $(500)^2 = (400)^2 + (300)^2$. If, on the other hand, the two smaller tank troops are given time to effect a junction, then the tank troop of 500 will be overwhelmed, for the fighting strength of the opposing force, 700, is no longer equal, but is ,in fact, nearly twice as great-namely, in the relation of 49 to 25.

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28 One difficulty is that the concentration is unlimited, and the effects of range limitations or force-to-space ratios are not taken into consideration in simple Lanchester models. The latter, however. may be specified externally to the model. For a discussion of force-to-space ratios, see John J. Mearsheimer, *Conventional Deterrence* (Ithaca, N.Y.: Cornell University Press, 1983), especially PP. 44, 181-183.

29 Lanchester believed that the effects of concentration would be most marked in air combat, where forces could concentrate their fire on each other in three dimensions. rather than just two. See Lanchester, *Aircraft in Warfare,* pp. 51, 138-139; and Lanchester, "Mathematics in Warfare," p. 2147.

Thus, there is a distinct advantage in concentrating forces because the square of the sum will be greater than the sum of the squares of the component forces.

The basic square law equations may be solved so as to give an equation for the attrition of the forces over time, the time to the end of the conflict, and the force level left for the victor. This set of equations forms the basis for simple square law models.[30] The Lanchester equations do not, in their basic form, provide for movement of the front. Movement of forces must either be specified separately or incorporated into an extended form of the basic Lanchester equations.[31] [Ref. 17: pp. 93-97]

When this square law is applied to the number of tanks on the Korean Peninsula, the tank gap should be greater than the numerical assessment. As discussed in Chapter III, NK has 3,450 tanks and the ROK has 1,500 tanks, and the USA has 150 M60A3 tanks. To measured the tank gap, the fighting strength of each tank might be calculated. Even though the number of tanks of both NK and ROK is known the effectiveness coefficient of each tank must be obtained from other sources. This is largely an empirical question and is beyond the scope of this thesis Therefore, the effectiveness coefficient will be ignored and it is assumed that each tank's coefficient is the same. Now the tank gap ratio is calculated as the square the each country's tanks. Thus the tank gap ratio is 5.29:1 ($3{,}450^2/1{,}500^2$). When U.S. tanks are added to ROKs number of tanks, the ratio is reduced to 4.37:1 ($3{,}450^2/1650^2$). This result is established by focusing on the number of tanks only. It should be further reduced because as mentioned in Chapter III the U.S.-ROK has a higher tank capability than NK, in areas such as nightfighting ability, automatic range-finder, computerized fire control and shoot when moving. Since the effectiveness coefficient is calculated by rate of fire times probability of kill of each shot, the coefficient of the U.S.-ROK should be much higher than NK.

A more important consideration is that the real dynamic situation of warfare is the combination of weapons not only tanks. At present NK has more aircraft than ROK, but there is almost no gap between the two countries close air support (CAS). When the U.S. CAS ability is added to the ROK NK's superiority in tanks does not exist any more Because the U.S. strategists contend that reinforcements of U.S. air power would give ROK and American air forces the ability to provide immediate sup-

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30 The square law is itself deterministic, since it is a differential equation, but a probability of winning the battle may be obtained from a stochastic analog of the square law.

31 See Weiss, "Lanchester-Type Models of Warfare," pp. 84-89, for an example of an extension of the basic square law that incorporates movement.

port to ROK ground forces, especially against NK armor. They would still meet the requirements of air defense, establishing air superiority over the battlefields, and penetration air strikes north of the DMZ. In addition, B-52s special capabilities (demonstrated in Vietnam), would be employed against massed formations of NK tanks. Thus the location of U.S. troops on the Korean Peninsula is essential for maintaining peace on the Korean Peninsula.

b. Linear Law

After presenting his "square law" as a model of combat in which the numerically superior side is able to bring that superiority to bear on the opposition, Lanchester turned to the description of combat that occurs in the sense of one-on-one engagements, so that the numerically superior side has an advantage only in having more eligible combatants. Lanchester's linear law drops the assumption of concentration of fire. Lanchester originally derived the linear law by considering ancient short-range weapons: soldiers equipped with weapons, such as swords, could find little advantage in concentration because several soldiers could not simultaneously attack an opponent. Ten men with swords fighting one man would have to fight him sequentially, as they could not all get close enough to engage him simutaneously. Under more modern conditions, the linear law may hold in artillery duels using indirect fire.

In the case of indirect fire, both sides are engaging in fire that is not directed against any one target but is evenly distributed throughout a given area. Firers do not have information on the effects of fire and do not shift fire to a new target when a target is disabled. Targets are "overkilled," and indirect fire is, therefore, less efficient than direct fire. This lack of retargeting means that fire is not concentrated as it is direct fire.

Artillery duels provide a good example of indirect fire. The rate of loss of Blue forces under fire will depend not only on the number of Red guns firing and Red's effectiveness, but also on the size of Blue's forces in the area under fire.[32] This can be seen by imaging a group of Blue artillery units destributed uniformly over an area and then subjecting the area to bombardment. If a constant amount of bombardment is assumed, then the more artillery units in the area, the more losses they will sustain per

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32 Effectiveness in this context is a different quantity than in the square law, although it is conceptually similar . In this case, the effectiveness is the number of expected casualties per target and per firer in a unit of time, whereas the square law effectiveness has units of expected casualties per firer in a unit of time. These two types of effectiveness are similar but are not directly interchangeable.

unit time.[33] Thus, the rate of loss is similar to that of the square law, with the addition of a term for the size of the force under attack. If homogeneous forces are assumed with the same weapons and vulnerabilities on each side, the equations for the linear law can be written as:

$$\frac{dB}{dt} = -BrR$$

$$\frac{dR}{dt} = -RrB$$

Integrating the above equations gives the linear law equality condition:

$$rR(0) = bB(0)$$

As with the square law, a series of equations may be derived that give information on attrition over time.[34] The linear law differs from the square law in several important respects. First, it does not give any special advantage to force level. The force level is not squared and counts for as much as effectiveness. Second, concentration of forces has no effect on reducing the winner's total casualties. Since both side's force level appears in the loss rate, adding more forces increases the number of targets in the area for the enemy to kill, as well as increasing the enemy's own loss rate. The battle may end sooner, but the winner will still lose the same number of troops. This is reflected in the fact that the differential casualty ratio for the linear law (dB dR = r b) does not depend on the force levels of the two forces.

Because the linear law does not exhibit the effects of concentration, it has been relatively neglected. The question of concentration should not lead to rejecting the linear law outright. Amassing forces to create local superiority in fighting strength is still feasible under the linear law and is necessary to success. The difference is that concentrating past the point where one wins is to no avail, whereas in the case of the square law, it helps to reduce the winner's casualties. [Ref. 17: pp. 100-103]

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33 One set of conditions using indirect fire results in the square law. If indirect fire, such as artillery fire, is maintained on an area that shrinks as targets are disabled so that a constant density of targets is maintained, we again obtain the square law. This is the case of a constant-density engagement. If the area is subjected to indirect fire, and the defense maintains a constant area, then the defenders should be attrited in accordance with the linear law.

34 Since the losing side's force level asymptotically approaches zero, it is not possible to give equations for the time to end of combat unless a fixed breakpoint is assumed. See Taylor, *Lanchester Models of Warfare*, pp. 91-102, 134-140.

When the linear law is applied to measuring the tank gap on the Korean Peninsula, it calculates a more favorable advantage to the ROK when compared to square law results. Since the effectiveness coefficient (r, b) is ignored, the linear law results are equal to the numerical comparison results in measuring the tank gap between NK and ROK; as discussed in Chapter III the ratio is 2.3:1. Using the linear law results in measuring the tank gap, the ratio should be reduced at a certain point primarily because the U.S.-ROK's tanks have a higher capability than NK's tanks in fighting strength. As mentioned before the real dynamic situation of warfare causes the U.S.-ROK to have a higher capability than NK in military strength. The U.S.-ROK has a firepower plan with three elements to counter an initial NK attack: (1) tactical air support from fighters and fighter bombers based in Korea, Japan, the Philippines, and with the Seventh Fleet; (2) artillery and anti-armor assets with ROK and U.S. ground units; and (3) massive air strikes from B-52 bombers based on Guam. [Ref. 2: p. 271] So the initial attrition rate of NK's tank should be high and it will be reduced the tank gap between NK and ROK significantly.

c. Critiques of Lanchester's Theory

Although dynamic models attempt to quantify and take into account many aspects of war that the static balance comparisons do not, they must necessarily rely on many assumptions concerning the conditions under which a war would be fought. Some of these conditions cannot be predicted, thus placing the credibility of such models' outcomes in question. Questions also arise concerning the equations used in the models, whether the model, or the scenario, is biased for or against a particular side, and the sensitivity of the model to different assumptions. Thus it would appear that a dynamic model may have as many disadvantages as advantages and does not necessarily offer a more reliable method for evaluating relative combat capability than some less sophisticated static models. Unfortunately, though directed at the right questions, the Lanchester equations offer a fundamentally implausible representation of combat under all but a very small set of circumstances. Lanchester theory suffers at least three serious problems.[35]

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35 This study is, of course, concerned specifically with problems beyond those encountered by all models (for example, the need to aggregate; to estimate effectiveness coefficients and other numbers; to idealize and simplify). A number of the aggregation and other problems that all models face are discussed in J.A. Stockfish, *Models, Data, and War: A Critique of the Study of Conventional Forces,* R-1526-PR, prepared for the U.S. Air Force Project Rand (Santa Monica, Calif.: Rand Corp., 1975).

(1) No Consideration of Withdrawal. A plausible model of ground war should capture the basic connection between attrition and the movement of the battle front. Historically, the basic rationale for withdrawal has been to reduce one's attrition; if a defender's attrition exceeds a certain threshold, he may withdraw, an action which reduces his attrition. Not one of the Lanchester models (for example, square law or linear law) reflects this essential feedback, nor is it mathematically possible for them to. Not one of these equations can capture the effect of withdrawal -a response to attrition- on the rate of attrition itself.

This is evident from Lanchester's attrition equations themselves. When solved for the opposing Red and Blue forces surviving at any time, t, the Lanchester square differential equations yield the following formulas:

$$R(t) = \frac{1}{2}\left[\{R(0) - \sqrt{\frac{b}{r}}\,B(0)\}e^{\sqrt{rb}\,t} + \{R(0) + \sqrt{\frac{b}{r}}\,B(0)\}e^{-\sqrt{rb}\,t}\right]$$

and

$$B(t) = \frac{1}{2}\left[\{B(0) - \sqrt{\frac{b}{r}}\,R(0)\}e^{\sqrt{rb}\,t} + \{B(0) + \sqrt{\frac{b}{r}}\,R(0)\}e^{-\sqrt{rb}\,t}\right]$$

R(t) and B(t) are the Red and Blue forces at time t, while r and b (real numbers between zero and one) are their respective Lanchester effectiveness coefficients. Clealy, R(t) and B(t) depend only on r, b, t (time), and the initial Red and Blue forces. The rate of withdrawal does not appear; thus withdrawal does not affect the rate of attrition. The same is true for all other forms of the Lanchester equations.

The ROK-U.S. defense strategy is governed by the forward defense concept. Forward defense requires that a NK invasion be halted and turned back north of Seoul by the ROK divisions and one U.S. division reinforced by U.S. and ROK air power. But when NK break the peace on the Korean Peninsula again, NK will use every weapon they can during the initial attack. At the initial time of war, ROK's attrition rate will be high. Therefore, the ROK government have prepared a plan to withdraw their troops at certain position to reduce the initial losses and prepare for counter-attack to NK. Therefore, withdrawal should be considered in real warfare. Withdrawal can also be used as a tactics to prepare for aneffective counter-attack and reduce unnecessary losses.

(2) No Consideration about Trading of Space for Time.. Because there is no feedback from withdrawal rates to attrition rates, the Lanchester expression for the duration of the war (that is, the time elapsed) gives exactly the same answer whether the defender withdraws a thousand miles or does not withdraw at all. The Lanchester duration (time) is totally independent of the amount or rate of withdrawal (space) and of the functional form chosen to calculate the velocity of the front. This, is easily demonstrated.

Letting t_{end} stand for the time (in days) required by Red to annihilate Blue, the square law duration will illustrate the general point. There are various ways to write the duration; one is:

$$t_{end} = \frac{1}{\sqrt{rb}} \ln\left(\frac{\sqrt{R_0^2 r} + \sqrt{B_0^2 b}}{\sqrt{R_0^2 r} - \sqrt{B_0^2 b}}\right)^{\frac{1}{2}}$$

Here again t_{end} obviously depends only on r, b, and the initial Red and Blue forces. The duration of the war, t_{end}, is totally independent of the amount or rate of withdrawal. The same is true of the duration formulas derived from other forms of the Lanchester differential equations. In short, the Lanchester equations are incapable of representing perhaps the most fundamental tactic in military history: trading space for time. Given Blue and Red forces and effectiveness ratings, how much longer does the war last if one adopts this movement function as against that movement function? The Lanchester equations are incapable of answering the question.

The ROK has established strong points along the invasion routes. These fortifications are intended to create bottlenecks along the relatively narrow invasion routes where anti-tank weapons, artillery, and air strikes would pour fire into NK troops and armor. So, when NK breaks peace on the Korean Peninsula, the ROK has a plan to withdraw at certain position between DMZ and Seoul. (for example, FEBA-ALPHA line) Then, the ROK will earn some time for preparing a counter-attack. In addition, the civilian economic production system can be transformed to support military strength. Since ROK's economic power is greater than NK's economic power, it is plausible that the ROK can overcome the initial disadvantage and can effectively defend itself from NK's invasion.

(3) No Consideration about Diminishing Marginal Returns. This point concerns the most famous and widely used result of Lanchester theory, the square law.

Given Red and Blue forces, Lanchester states this famous square stalemate condition as follows: "the fighting strengths of the two forces are equal when the *square of the numerical strength multiplied by the fighting value of the individual units are equal.*"[36] What he called *fighting values* are simply the Lanchester coefficients, *b* and *r*. Thus, in modern notation the square law says that a Blue force, B(0), will stalemate a Red force, R(0), only if:

$$bB(0)^2 = rR(0)^2.$$

Equivalently, the effectiveness ratio, b/r, must equal the square of the numerical ratio, R(0)/B(0), for Blue to stalemate Red. So, for example, to stalemate an adversary three times one's size (in lethality units), it does not suffice to be three times as effective (per unit), or even six, seven, or eight times. Rather, one must be fully nine times as effective. There simply is no convincing evidence of this; indeed, there is impressive evidence to the contrary.[37] As noted below, one of the necessary (though not sufficient) conditions for any of the Lanchester equations to hold is that no movement (that is, defensive withdraw) of the front be possible (since movement would have some effect on attrition rates, a feedback precluded in the Lanchester equations). What sorts of military engagements would qualify? Assaults on small, defended islands, for example.

An island roughly five miles long, where the defender was basically surrounded, and where movement of the front was all but impossible is among the special cases to which Lanchester equations may apply. It is the only case in which there is any statistical correspondence between events as they unfolded and as hypothesized by the Lanchester equations. Even if the statistical fit were good, there would be no basis for extrapolation to cases where movement is possible (for example, Korean Peninsula) And, in fact, the fit is not good.

History's refusal to conform is not surprising when one notices that, at bottom, the Lanchester square equations deny a phenomenon to which virtually all

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36 Lanchester, *Aircraft in Warfare*, p. 48. Lanchester's emphasis. A stalemate is, of course, a fight to the finish in which both sides are drawn to zero.

37 By the same arithmetic, acceptance of the square law forces one to interpret given outcomes in questionable ways. For example, if one side stalemates (fights to zero-zero) an adversary five times as numerous the Lanchesterite is mathematically compelled to conclude that the smaller force was twenty-five times as effective (that is, if stalemate occurred, then the effectiveness ratio equaled the square of the numerical ratio).

social processes - including war- are subject: the phenomenon is diminishing marginal returns. To see this, a brief derivation is necessary.

The Lanchester square law is derived from the Lanchester square differential equations:

$$\frac{dR}{dB} = \frac{bB}{rR}$$

from which the famous square law is obtained directly by integration.[38] Let us take a closer look at equation (dR/dB = bB/rR), which implies the square law.[39] It asserts that the instantaneous casualty - exchange ratio, dR/dB - the limiting ratio of Reds killed per Blue killed - is a linear function of the force ratio, B/R.

Thus the casualty-exchange rate, dR/dB, grows at a constant - *never marginally diminishing* - rate, b/r, as the force ratio, B/R grows. No crowding, no force-to-space constraint, ever sets in to moderate the "concentratability" of Blue's force. This is highly implausible; it is the essence of the Lanchester square law.

Some forms of the Lanchester differential equations do not imply a square relation (for example, the linear law), while others, allow for asymmetrical solutions in which one side enjoys a square effect and the other does not (the so-called ambush variant).[40] Where (a) no diminishing marginal returns set in (for example, no force-to-space constraints apply) and (b) where movement of the front is precluded,

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38 Seperating variables and integrating equation dR/dB = bB/rR, can obtain the Lanchester square state equation:

$$r(R(0)^2 - R(t)^2) = b(B(0)^2 - B(t)^2)$$

Setting $R(t) = B(t) = 0$, the familiar stalemate condition, or N^2 law, follows:

$$rR(0)^2 = bB(0)^2$$

or

$$\frac{b}{r} = \left(\frac{R(0)}{B(0)}\right)^2$$

As noted above, the effectiveness ratio, b/r, must equal the square of the numerical ratio, R/B, to stalemate.

39 In fact, the above equation both implies and is entailed by the Lanchester square state equation given in the above note; hence the two are equivalent.

40 This may well be the most plausible of all Lanchester variants, when applied to guerrilla engagements. See S.J.Deitchman, "A Lanchester Model of Guerrilla Warfare," *Operations Research*, vol. 10 (Novemember - December 1962), pp. 818-27; and Taylor, *Lanchester Models of Warfare*, vol. 1, pp. 169-81.

certain forms may be more or less appealing. But as noted above, no form of the Lanchester equations registers, or can register, the effect of withdrawal (a response to attrition) on the rate of attrition itself. For that reason, they suffer the serious problems set forth at the outset. [Ref. 16: pp. 4-13]

In terms of Lanchester's law, ROK has apparently little chance of winning because at present the ROK's military strength is less than NK's. Even though ROK weapon's capability is better than NK's, according to the Lanchester law the ROK cannot overcome the tank gap. Therefore, when Lanchester model is applied on the Korean Peninsula, it should consider the diminishing marginal returns.

Given the qualitative differences, outlined in Chapter III, it is clear that a realistic assessment of the relative combat potential of the tank fleets of the ROK and NK must take into account both quantity and quality. Assessment of quality is bound to be more subjective than a bean count of number of tanks in service. The starting point for estimating the balance of combat potential is the number of tanks facing each other in the main area of operations.

Historic experience of tank warfare between countries equipped with Western (include U.S) and Soviet tanks respectively suggests that an exchange ratio of 2:1 or more in the Western (U.S.) tanks favor is possible.[41] Many analysts believe that NATO (U.S.) will enjoy an even more favorable exchange ratio -up to 6:1- because they assume that NATO will have the advantage of being on the defensive. This assumption is the same on the Korean Peninsula. ROK-U.S. tank's inferiority in number of tanks will not impact seriously on the real dynamic situation even though the exchange rate is not 6:1, as in Europe.

According to a recent report, arms buyers can expect to pay at least three times as much on the world market for an M60A3 or a Leopard 1 as for a T-55.[42] This large price differential reinforces the contention that older U.S. (Western) models are of considerably greater combat value than their Soviet counterparts. Thus, the tank gap between NK and ROK is not as significant a problem in a dynamic situation.

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41 Posen, "Measuring the European Conventional Balance," pp. 80-81.

42 Ian Curtis, "Tankionics: New Subsystems for Armor," p. 17; and "Standard Arms Prices," *Defense and Foreign Affairs*, Vol. XVI, No.2 (1988), p. 47.

2. Epstein Model

For decades Lanchester equations dominated dynamic analysis, but Lanchester's equations fail to capture warfare's basic dynamics and present a fundamentally misleading picture of war. Joshua M. Epstein contends this in his study.[43] He then presents new, alternative equations of his own. These, he contends, more accurately represent the core dynamics to which Lanchester theory is oblivious. Besides being of theoretical interest, Epstein's methods have immediate practical relevance in such pressing policy areas as force planning and defense budgeting. This section introduces a brief description of the Epstein's dynamic model without any mathematical equation form.

The attacker makes an opening "bid" on the pace of war, the rate at which his own forces are consumed (he can, of course, set his rate at zero by not attacking). He may want to press the attack at an extremely high pace, and be willing to suffer extremely high attrition rates, if -for operational, strategic, or political reasons- a quick decision is paramount. A casualty-exchange ratio (defenders killed per attacker killed) imposes an attrition rate on the defender. The latter may elect to hold his position and accept this attacker-dictated rate, or he may choose to redece his (and in turn the attacker's) attrition rate by withdrawing at a certain speed.

Operational, strategic, or political factors may preclude a defender's trading space for time. However, given its tactical advantages, so eloquently described by Clausewitz, a plausible model should permit it.[44]

The adaptive model of war offered by Epstein does so and also yields a more realistic picture of movement on the ground. Rather than the smooth velocity curves generated by traditional (no feedback) methods, these equations generate a jagged sequence of velocities reflecting the alternation of action and inaction so characteristic of real war. [Ref. 16 : p14]

Epstein's model, which attempts to simulate the conduct of a conventional war of attrition, is based on the premise that both the attacker and defender will accept some level of attrition to their forces in an effort to attain some objective. For the attacker, the objective might be to gain territory, and the defender's goal might be to repel the

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43 Joshua M. Epstein, *The Calculus of Conventional War: Dynamic Analysis without Lanchester Theory*, Washington, D.C.: Brooking Institution, 1985.

44 Carl von Clausewitz, "Retreat to the Interior of the Country," *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton University Press, 1976), bk. 6, chap. 25, pp. 469-79.

attacker without losing ground. Epstein has assumed, however, that there is some level of attrition beyond which each side is willing to abandon its objective, at least temporarily; that is, when losses become too high, the aggressor might stop pressing the attack. Likewise, the defender might be willing to withdraw to a new position to avoid further losses, at least for the moment.

Epstein attempts to capture these phenomena through mathematical equations describing each side's starting position and losses for each day of a theoretical war. When hostilities begin, each side's total forces can be assigned a numeric value, such as the weapon effectiveness index/weighted unit value (WEI/WUV) score described in Chapter III. In addition, each side might start out with a specific number of ground-attack aircraft with which it can inflict losses on the other side's ground forces. As the war progresses, each side loses ground combat capability and aircraft as determined by the equations Epstein has developed. The defense, in order to maintain its losses at an acceptable level, gives up ground. The mathematical process of removing ground and air assets can continue for a specified number of days or until one side is decimated.

Epstein's dynamic model also has limitations. Epstein's model, like any quantitative method for evaluating the relationship between two military forces, cannot be used to predict the outcome of an actual conflict. No mathematical model, even one that attempts to capture the dynamics of warfare, can replicate all the factors that determine the course of a battle. Indeed, some factors that have a large impact on the outcome of a conflict -such as leadership, morale, and tactical competence- that cannot be quantified. Others, such as location of the attack, weather and other conditions at the time of attack, and the element of surprise cannot be predicted. [Ref. 14: p. 77]

When measure the dynamic situation of warfare on the Korean Peninsula of the whole ground forces and CAS capability, the Epstein model is more applicable than the Lanchester model.

B. ADVANTAGE OF DYNAMIC MODELS

Dynamic comparisons take into account each side's ability to destroy the other and the effect of attrition over time. Such models, however, require much of the same quantitative information included in static balanced and more. Dynamic comparisons can be viewed as starting where static comparisons end. In addition to counting each side's equipment, dynamic models also simulate the destruction of the opposing's weapons, depending on the ability of each side's systems to do so. Thus, the ability of

each combatant's weapons to find and destroy the enemy's weapons and the rate at which this can be done determine the outcome of a force comparison. In this way, dynamic models can, based on numerous assumptions and inputs, simulate the interaction of many different types of weapons, the impact of different strategies, and the contribution of logistic support.

Calculation of dynamic balance, however, requires many detailed inputs; many assumptions about the interactions of individual governing it; judgments concerning the behavior of commanders on each side; and, generally, large computers to process the numbers. Furthermore, since dynamic assessments of force balance depend on the conduct of war, they are highly dependent on local force concentration. Finally, the outputs of such models typically describe the amount of territory a military unit has ceded to its attacker after so many days of war, or the number of enemy tanks and aircraft destroyed by each side. [Ref. 14: pp. 81-83]

V. CONCLUSION

The NK's superiority in tanks on Korean Peninsula has usually been overstated. Even though the numerical advantage is 2.3:1, the superior quality of U.S.-ROK tanks largely offsets even this modest lead, and may even mean that the U.S.-ROK tank force has greater combat potential. As mentioned in chapter III most U.S.-ROK tanks have considerable advantages in their capabilities for observation, firepower, tactical mobility, and armor protection. The uncertainty is in determining how big an allowance to make in translating the U.S.-ROK quality advantage into combat potential.

According to a ROK government pronouncement, the ROK's conventional military strength is only 66 percent that of NK. When the U.S. forces located in ROK, are added in, the combined force is only 72 percent that of NK. This percentage is improved, compared to the last year's 65 percent (70 percent when U.S. troops were added), but it is probably not enough. Therefore, it is recommended that the ROK government should continuously invest 5 percent of the ROK's GNP to improve it's military strength. Military balance with NK can only be achieved through this investment.[45] Since the ROK's economic power is greater than that of NK and the ROK's military spending is greater than NK since 1985, the military strength gap (including the tank gap) will be reduced continuously. So, the location of U.S. troops on the Korean Peninsula is essential until the ROK can provide it's own self-defense capability. Before considering the withdrawal of the U.S. troops from the Korean Peninsula, the role of the U.S. troopsshould be carefully studied and understood. U.S. troops provide the deterrent that prevents another war on the Korean Peninsula and contributes to maintaining the peace in Far Eastern Asia. Therefore, the U.S. troops role should not be underestimated.

The ROK government does not anticipate having U.S. troops in the ROK forever. Nor, it seems,does the U.S. anticipate having troops in the ROK forever due to the limited budget for U.S. military support. Therefore, when the U.S. government reduces or withdraws all of the U.S. troops from the ROK, it should be done only when the military balance between NK and the ROK is established. Also, U.S. troop withdrawal should not occur until the conventional military balance between the Eastern and Western blocs in the Far Eastern Asia is acheived.

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45 The Korea Central Daily (Korean Version), Oct. 26 1986.

ROK armed forces ought to work toward a more autonomous and multifaceted capability and must continue to strengthen forward defense assets, especially the hardening of antitank gun positions. Existing programs such as the procurement of TOW anti-tank missiles and Hughes anti-tank helicopters should continue. The ROK air force appearently has begun a trend toward orienting more of its fighters to a ground support, anti-tank role and hopefully, this trend will continue. A longer conflict with limited outside reinforcement would require a more mobile ROK army for purposes of elastic defense and counter-offensive operations. Steps to enhance these capabilities could require a 50 to 100 percent increase in the number of tanks in order to form two to three armored or additional mechanized divisions as a strategic reserve. [Ref. 2: p. 275] The ROK reportedly wants to build at least 700 K-1 MBTs. Building these K-1 MBTs would contribute significantly to reducing the tank gap between NK and ROK.

The ROK government also should weigh the possible Soviet and NK reaction. Soviet policy toward to the ROK remains unfriendly and there is little prospect for improvement. If the USSR continues its military buildup in the Northwest Pacific and does not establish friendly contacts with the ROK, the ROK then would be justified in changing its defense policies by the early 1990s to take into account the Soviet threat. Moreover, if the Soviets gain further strategic access to NK and expand the supply of arms to NK, the ROK and the U.S. undoubtedly should move rapidly to develop anti-Soviet missions.

APPENDIX A. ARMS TRANSFERS TO NORTH KOREA 1950-1987

Date Order	Sup-plier*	Quan	Item	Date Del'd	Remarks
1950	China	100	MIG-15	1950-51	Built in USSR
		35	La-9	1950-51	
		200	BA-64	1950-51	
		100	SU-76	1950-53	
		100	BTR-40	1950-57	
		150	BTR152	1950-59	
		450	T-34 Tank	1950-52	
1951		35	Tu-2	1951-52	
		10	I1-12	1950-52	
1953		100	MIG-15	1953	
		5	I1-28	1953	
		70	La-11	1953	
		2	I1-28U	1953	
		8	Li-2	1953	
		5	Mi-1	1953	
		15	Yak-17 UTI	1953	
		15	MIG-15 UTI	1953	
1954		10	Yak-11	1954	
		4	Patrol Boats, "MO 1" Type	1954	
		8	Fleet Minesweepers, "Fugas" Type	1954-55	
1955		30	I1-28	1955	
1956		100	MIG-17	1956-58	
		12	Mortar Torpedo Boats "P4" Type		
1957	China	4	Fong Shou No. 2 Fighters	1957	AN-2 produced under license in China
	China	24	Inshore Minesweeper	1957-60	
1958	China	80	MIG-15	1958	
	China	40	I1-28	1958-59	
	China	4	I1-28U	1958-59	
	China	20	Shenyang Yak-18	1958-59	Supplement those supplied before '50 by Soviets
	China	300	Shenyang F-4	1959-60	

Date Order	Sup-plier*	Quan	Item	Date Del'd	Remarks
1959	China	20	MIG -19	1959-60	
		2	Patrol Boats "Artillerist" Type	1959	
1963		2	Minesweeper "T43" Type	1963	
		9	Motor Torpedo Boat "P4" Type	1963	
1965		14	MIG-21FL	1965	
		15	I1-14	1965	
		3	MIG-21 UTI	1965	
		5	AN-24	1965-66	
		100	Su-100	1965-66	
		250	BTR 152	1965-71	
		250	BTR 40	1965-71	
1966		150	PT-76	1966-68	
		21	MIG-21	1966	
		360	SA-2 SAM	1966	
		20	MI-4	1966	
1967		70	T-54/55	1967	
		2	Submarine "W" Class	1967	
		7	Gunboat "MGR" Type	1967	
		3	Torpedo Boats, "PTF" Type	1967	
	China	4	Patrol Boat"Shanghai"	1967	
		18	Torpedo Boat "p4"	1967	
1968		4	Gun Boat "TG" Type	1968	
		65	MIG-21	1968-71	
		390	K-13 "Atoll" AAM	1968-71	
		250	T-54/55 Tanks	1968-70	
1971		28	SU-7 FGA	1971	
		40	"FROG-5" SSM	1971	
		3	"Samlet" SSM	1971	
		132	"Styx" ShShm	1971-72	To arm 8 "OSA" Class & 6 "Kormar" Class Patrol Boats
		8	Missile Boat, "Osa" Class	1971-72	
		6	Patrol Boat, "Komar" Class	1971-72	
1972		200	SA-7 SA Missile	1972-73	
		20	Frog 7 Arty Rocket	1972-73	
		50	T-55 Tanks	1972-73	
		2	Submarine "W" Class	1972-73	

Date Order	Supplier*	Quan	Item	Date Del'd	Remarks
1973	China	2	Submarine "Romeo-L"	1973	Coproduced w/China
1974	China	2	Submarine "Romeo-L"	1974	
	China		T-59 Tanks	1974	
		2	MIG-21 MF	1974-78	Latest version licence prod. begins '78
			Frog-7 SSM	1974	Deployed at est. 2 sites
1975			SS-N-2 "Styx" ShShM	1975	To arm new missile boats
			Fast Patrol Boats	1975	
		50	T-62 Tanks	1975	
	China	3	Submarine "Romeo-L"	1975	
1976	China	2	Submarine "Romeo-L"	1976	
1978			MIG-23?		
1982	China	20	F-6 Fighter	1982	
1983		20	MIG-21F	1983	
1984		30	MIG-23	1984	Fighter
		26	MIG-23	1985	Fighter
		24	MIG-23	1986	Intercepter
		90	AA-7Apex	1985	Reportedly
		90	AA-7Apex	1986	Arming MIG-23s
1985		8	M1-14Haze	1986	For ASW
		24	M1-17Hip-H	1986	
		15	M1-24Hind-D	1985	Unconfirmed
		30	M1-24Hind-D	1986-87	
		24	M1-8Hip	1986	Helicopter
1987		3	Su-25 Frogfoot	1988	

Supplier* is the Soviet Union unless indicated in this column. More often than not, "date ordered" and "number ordere" are not available. Information on arms transfers to North Korea is sketchy and difficult to obtain.

SOURCES: SIPRI Yearbook 1972, p. 137; SIPRI Yearbook 1973, p. 333;
SIPRI Yearbook 1974, p. 274; SIPRI Yearbook 1975, p. 232;
SIPRI Yearbook 1976, p. 266; SIPRI Yearbook 1977, p. 324;
SIPRI Yearbook 1978, p. 268; SIPRI Yearbook 1979, p. 278;
SIPRI Yearbook 1980, p. 171; SIPRI Yearbook 1981, p. 255;
SIPRI Yearbook 1982, p. 251; SIPRI Yearbook 1983, p. 348;
SIPRI Yearbook 1984, p. 245; SIPRI Yearbook 1985, p. 403;
SIPRI Yearbook 1986, p. 386; SIPRI Yearbook 1987, p. 254;

SIPRI Yearbook 1988, p. 235;

Arms Trade Registers. The Arms Trade with the Third World, SIPRI 1975, pp. 10-12; FEER Asia Yearbook 1980, pp.48,211; "Home Made Romeos," Aviation and Marine, Jan 1977, p. 29; (1950-1979 data extracted from: "Arms Transfers and Security Assistance to the Korean Peninsula 1945-1980: Impact and Implementation," Thesis by Richard P. Cassiby, Jun 1980, USNPG, Monterey, CA.)

APPENDIX B. ARMS TRANSFERS TO REPUBLIC OF KOREA 1950-1987

Date Order	Supplier*	Quan	Item	Date Del'd	Remarks
1950		75	NA F-51 Mustang	1950-52	
		15	Piper L-4	1950-52	
		15	Douglas C-47	1950-52	
		20	Curtiss C-460	1950-53	
		2	Frigate, "Tacoma" Class	1950	
		1	Patrol Boat "PC"	1950	
		100	M-Sherman Tanks	1950-51	
		50	M-5 Stuart	1950-51	
		50	M-24 Chaffee	1950-53	
		70	M-10	1950-53	
		200	M-8 Greyhound	1950-59	
1951		500	M47/48 Patton Tank	1951-56	
		2	Frigate, "Tacoma" Class	1951	
		4	Patrol Boat "PC"	1951	
1952		4	Patrol Boat "PCS"	1952	
		4	Mortar Torpedo Boat	1952	
1953		1	Frigate. "Tacoma" Class	1953	Replacement
	Norway	2	Oiler	1953	
1954		70	M-36	1954-60	
		3	Aero Cdr 520 Aircraft	1954	
1955		5	NA F-86F Sabre	1955	
		1	Oiler	1955	On Loan
		2	Tank Landing Ship	1955	
		2	Escoat "PCE" Ships	1966	On Loan
		6	Supply Ship	1955-57	
1956		2	Escoat "PCD" Ships	1956	
		1	Tank Landing Ship	1956	
		2	Frigate, "Bostwick" Class	1956	
		9	Medium Landing Ship	1956	
		3	Coastal Minesweepers	1956	
		75	NA F-86F Sabre	1956	10-20 Converted to Recce Version
		6	Sikorsky S-55	1956	
1957		4	Coastal Minesweepers	1957	Decommissioned in 1962
		3	Medium Landing Ships	1957	
		9	Lockheed T-33A	1957	
		5	Cessna O-1A Birddog	1957	Recce Plane

Date Order	Sup-plier*	Quan	Item	Date Del'd	Remarks
1958		30	NA F-86F Sabre	1958	
		3	Tank Landing Ship	1958	
		12	Honest Jone SSM	1959	
		2	Tank Landing Ship	1959	
		1	Escoat Transport	1959	Modified Destroyer Escoat MPA Transfer
		3	Coastal Minesweeper	1959	
1960		1	Rocket Landing Ship	1960	
		2	Patrol Boat "PC"	1960	
		1	Landing Craft Repair Ship	1960	
		30	NA F-86D Sabre	1960-62	Equipped w/3 Sidewinder A
		5	Cessna LC-180	1960	
1961		4	Escort, "PCE" Type	1961	
		150	M-113 APC	1961-65	
1962		2	Tug	1962	
		30	NA F-86D Sabre	1962	Equipped w/ Sidewinder AAM
		16	NA T-28	1962	
1963		1	Destroyer "Fletcher"	1963	
		1	Frigate "Rudderow" Class	1963	
		1	Escoat "Auk" Class	1963	
		2	Coastal Minesweeper	1963	MAP Transfer
1964		1	Patrol Boat "PC"	1964	
		8	Cessna 185 Skywagon	1964	
1965		15	Cessna O-1E Birddog	1965	
		30	F-5A Freedom Fighter	1965-66	
		150	HAWK SAM	1965	
		4	Curtiss C-46D	1965-66	MAP
		50	105mm Howitzer	1965-66	
		50	105mm Howitzer	1965-66	MAP
1966	Japan	2	Kawasaki-Bell KH-4	1966	
	Canada	10	DHC-2 Beaver	1966	
		2	Escoat Transport	1966	
		60	203mm Howitzer	1966-67	MAP

Date Order	Supplier*	Quan	Item	Date Del'd	Remarks
1967		5	Douglas C-54	1967	
		2	Curtiss C-46	1967-68	MAP
		5	Cessna O-1A Birddog	1967-68	MAP
		3	Escoat Transport	1967	2 Transferred under MAP
		2	Escort "Auk" Class	1967	
1968		2	F-5B Freedom Fighters	1968	MAP
		40	F-5A Freedom Fighters	1968	
		1	Coastal Minesweeper	1968	MAP
		1	Coastal Minesweeper	1970	MAP
		2	Destroyer "Fletcher Class	1968-69	On Loan
		1	Hydrographic Survey Vessel	1968	
		9	Patrol Boats	1968-69	
1969		19	F-4E Phantom	1969	$52m - ROK $48m - US MAP
		5	Bell UH-ID Helicopters	1969	$2.4m
		700,000	M-1 Rifles	1969	
1971			M-16 Rifle Factory	1971	$10m Factory Contract Replaced F-5s sent to Vietnam, leased until 1976, Bought for $46.5m
		18	F-4D Phantom	1972	
		10	Gurmman S-2 Tracker	1971	
		12	Honest John SSM	1971	
		2	Bell 212 Twin Pac	1971	
		50	203mm Howitzers	1971	MAP
		50	M-113A APC	1971	MAP
		50	M-60 Tanks	1971	Trans f/US 7th Div
		50	M107 Howitzer	1971	
		50	M-48A2C Patton Tank	1971	MAP
		1	Patrol Boat	1971	
		1	Oiler	1971	
		1	Supply Ship	1971	
		2	Destroyer "Gearing" Cl	1972	On Loan
		4	Pazmany PL-2 Light Aircraft	1972	Built for Evaluation

Date Order	Sup-plier*	Quan	Item	Date Del'd	Remarks
1972		72	F-5E Tiger Fighters	1974-22 1975-24 1976-21 1977-2	MAP MAP MAP MAP
			Hughes AGM-65 Maverick ASM	1975-76	To Arm F-5Es
		733	AIM-9J Sidewider AAM	1974-220 1975-240 1976-210 1977-63	
		1	Patrol Boat	1973	
		2	Coastal Minesweeper	1975	MAP
		22	T-33A Lockheed Trainer	1972-4 1973-4 1974-4 1975-4 1976-4 1077-2	
1973		3	Fast Patrol Boats PSMM	1973-74	$16m Credit
	Britain	2	HS 748 Transports	1974	
1974		4	Coastal Patrol "Tarcoma" Class	1977-2	3 Others being produced by SK under license
		7	Fast Patrol Boats PSMM	1975-2 1976-2 1977-3	
		40	Standard ShShM	1975-77	8 Launchers -Use w/PSMM Ships
1975			Solid Fuel Rocket Motor Plant from Lockheed Corp	1975	$2m
		19	F-4E Phantom Fighters	1978-79	$178m; arms; Sidewider AAM & Maverick ASM
		54	F-5F Tiger-2	1978-79	$205m; followup order to 72 Ordered in '72
		120	Harpoon ShShM	1978-79	$81m; mil trans-port equip, spares, training
		600	AIM 96 Sidewinder AAM	1977-79 (480 ea)	Arming F-4 Fighters
		1	"Casa-Grande" Class Dock Landing Ship	1976	Arms; AA Guns
		2	"Gearing" C1 Destroyers	1977 (2 ea)	In add. to 2 Prev. Acquired
		66	Vulcan 20mm AAG	1975	

Date Order	Supplier*	Quan	Item	Date Del'd	Remarks
1976		34	"Hughes" 500/MD Armed Helicopter	1976-78	$50m for Total of 100; 66 License Produced by S.K., 4 Del in '76 w/o arms; arms: TOWATM
		24	Rockwell OV-10G Bronco Observ. Helicopter	1977	$58.2m; partof Total $116. 1m sale before FY-77
		200	Hughes AGM-65A Maverick ASM	1977-78 (150 ea)	$10.2m, arming 60 F-5Es
		1152	Hughes TOW ATM	1977-78	(720) Arm Heli.
		421	M-48 Main Battle Tank	1977	$36.6m f/Conversion to M-48A3/A5
		3	"Asheville: Class Fast Missile Boats	1975-76	New Const.; 4 more buile under license in S.K.
		?	Lance SSM	1977	To replace Honest John & Sergeant
		12	Cessna A-37A COIN/ Trainer	1977	
		10	Bell AH-1J Heli Gunship	1977	
		10	Fairchild C-123 Transport	1977	
		100	Hughes-500M Defender Hel Missile	1977-30	
		45	Nike Hercules SAM	1977	
1977		341	AIM-7E	1979	
		45	Bell UH-1H Cobra Heli.		$40m
		20	Bell UH-18 Heli.	1977	$1.1m
		100	Laser Guided Bomb Kits	1977	$3.7m
		6	Lockheed C-130H Hercules Transports		$7.6m
		18	F-4E Phantom Fighter		$156.2m
		24	Honest John SSM	1978-79	Trans fm U.S. Forces
		15	M-88 A1 Tank Recovery Vehicle	1978	$12m
			MIM-23B Hawk SAM	1978	$82m
1978	France	?	MM-38 Exocet ShShM		UNK #Ordered
		72	A-10A Fighter	1978-2	Pending approval for remainder
		?	M-48A3 Tanks		$7.1m
		6	CH-47C Chinook Heli.		Pennding approval
		2208	Hughes BGM-71A-1 Air-to-Surface TOW ATM		Pennding approval
		4	Patrol Ship "Asheville:		
		37	M-109A2 SP Howitzer		$24m
		1	Patrol Boat "Grasp"	1978	

Date Order	Supplier*	Quan	Item	Date Del'd	Remarks
1979		1800	Hughes BGM-71A TOW ATM s/10 Launcher		$13.7m
		4	AN/TSZ-73 Missile Minder		$29m
		60	F-4E		Pennding LOA
		180	F-16A/B Fighter		Disapproved by President
1980		15	F-5E Tiger 2	1982	Fighter
		32	F-5E Tiger 2	1982	Traniner
1981		30	F-16C	1987-89	$931m
		6	F-16D		
		12	A-10A		
		1089	M-551 Sheridan	1984	Unit price $10,000
		?	MIM-23B Hawk		
		21	M-88-A1	1984	
1982		30	F-16A		$931m
		5	F-4D Phantom		Compensation for attrition losses
		42	LCTP-7A1		
		85	MIM-23B Hawk		
1983	Brazil	30	T-37C	1983	Trainer
		298	MIM-23B Hawk		
1984		20	Model 205 UH-1H	1985	For Army
1985		4	F-4E Phantom	1985	US Surplus
		2	CH-47C Chinook	1985	
		150	FIM-92A Stinger	1987	$57m
		144	RGM-84A Harpoon	1985	
		21	Model 208 AH-1S		$178m
1986		50	Model 205 UH-1H		$115m
		672	BGM-71D TOW-2		Arming AS-15 Cobra Heli.
1987		6	C-130-301987		
		24	F-4D Phantom	1987	$77m
		144	AIM-7M Sparrow	1987	Arming 24 F-24D
		704	BGM-71D TOW-2	1987	

*Supplier is the United States unless indicated in this column

SOURCES: SIPRI Yearbook 1968/69, p. 236; SIPRI Yearbook 1969/70, p. 349; SIPRI Yearbook 1972, pp. 138-39; SIPRI Yearbook 1973, pp. 334-35; SIPRI Yearbook 1974, p. 274; SIPRI Yearbook 1975, p. 232;

SIPRI Yearbook 1976, p. 266; SIPRI Yearbook 1977, pp. 324-25;
SIPRI Yearbook 1978, pp. 268-69; SIPRI Yearbook 1979, pp. 222-25;
SIPRI Yearbook 1980, p. 148; SIPRI Yearbook 1981, p. 256;
SIPRI Yearbook 1982, p. 251; SIPRI Yearbook 1983, p. 251;
SIPRI Yearbook 1984, p. 245; SIPRI Yearbook 1985, p. 403;
SIPRI Yearbook 1986, p. 386; SIPRI Yearbook 1987, p. 254;
SIPRI Yearbook 1988, p. 236;

"Foreign Military Markets," Defense Marketing Services (DMS) (Greenwich: DMS, 1976) South America/Australasia (South Korea); "Foreign Military Markets," (1950-1979 data extracted from: "Arms Transfer and Security Assistance to the Korean Peninsula, 1945-1980: Impact and Implecation," Thesis by Richard P. Cassiby. US NPG, Monterey, CA, June 1980.)

APPENDIX C. TANK TYPES AND THEIR CHARACTERISTICS

TABLE 6. ROK-U.S. TANK TYPES AND THEIR CHARACTERISTICS

TANK MODEL	M1*	M48A3	M60A3
Country of origin	USA	USA	USA
Manufacturer	GDLS	Chrysler	GDLS
First in service	1980	1964	1961
Crew	4	4	4
Combat weight (kg)	54,500	47,200	51,980
Kerb weight (kg)	51,970	45,000	48,100
Length, gun forwards (m)	9.78	8.68	9.44
Length, gun in lock (m)	8.97	7.44	
Length of hull over tracks (m)	7.92	7.44	
Width, with skirt plates (m)	3.65		
Height to top of cupola/sight (m)	2.89	3.12	3.46
Height to turret roof (m)	2.37		
Ground clearance (cm)	48	41	46
Width of track	63	71	71
Length of track on ground (m)	4.65	3.98	
Firing height (M)	1.89		
Max. road speed (km/h)	72	51.5	48
Max. cross-country speed (km/h)	48	32	20
Cruising speed, road (km/h)	48		
Road range (km)	496	464	500
Fuel capacity (litres)	1,880	1,420	1,430
Fuel consumption, road (km/h)	376	312	286
Max. solpe (%)	60	60	60
Max. side-slope (%)	40	30	30
Vertical obstacle (m)	1.25	0.91	0.91
Gap crossing (m)	2.75	2.59	2.6
Fording, with preparation (m)	2.38	2.40	2.44
Fording, w/out preparation (m)	1.22	1.22	1.23
Type	indidual		
Heater	yes		
Escape hatch in hull	no	yes	
ARMARMENT			
Main armament calibre (mm)	105	90	105
Type	rifled	rifled	rifled
Length of tube (calibres)	51	48	51
Type of ammunition	APFSDS, APDS-T APERS-T, HEAT, smoke	HVAP-PS, HEAT, HE-P, HE, WP, illuminating, canister	APFSD, APDS-T, APERS -T, HEAT smoke
Max. rounds carried	55	62	63
Ready rounds	22		
Rounds in turret	55		

TANK MODEL	M1*	M48A3	M60A3
Coaxial armament			
Type	MG	MG	MG
Calibre (mm)	7.62	7.62	7.62
Rate of fire (rounds/min)	650-900		650-900
No. of rounds stowed	10,000	6,000	6,000
Anti-aircraft armament			
Type	MG	MG M2	MG M85
Calibre (mm)	12.7	12.7	12.7
Rate of fire (rounds/min)	450-550		1,050
No. of rounds stowed	1,000	630	900
Secondary armament			
Type	MG		
Calibre (mm)	7.62		
Rate of fire (rounds/min)	650-900		
No. of rounds stowed	1,400		
SIGHTS AND FIRE-CONTROL SYSTEM			
Turret drive	electro-hydraulic	electro-hydraulic	electro-hydraulic
By cdr/gnr	both	both	
Max. traverse rate (o/s)	23	24	4
Max. elevation rate (o/s)	6.3		4
Gun stabilizer	yes	no	
Optical rangefinder/type	no	yes/coin-cidence	laser
Laser rangefinder/type	yes/Nd-YAG	no	yes/Nd-YAG
Max. range (m)	7,990		
Min. range (m)	200		
Ballistic computer	yes	yes	yes
Range setting	automatic		
Gunner's primary sight		M20A4	AN/VSG-2+ TTS
Magnification	*9.8,*3,*1		*8
Field of view (mils)	109,302,320		
Gunner's auxiliary sight	periscope	periscope	telescope
Magnification	*8		*8
Field of view (mils)	142		
Commander's primary sight	ext. of GPS	in rangefineder	
Magnification	*3	*1.5	*7, *7.1
Field of view (mils)	373	850	
Gunner's night sight	T1		
Magnification	*3, *9.8		
Field of view (mils)	150*290, 45*87		
Driver's night sight/type	yes/II	yes/IR	yes/IR
Magnification	*1		
Field of view (mils)	612*787		

TANK MODEL	M1*	M48A3	M60A3
ENGINE AND TRANSMISSION			
Engine designation	AGT-1500	AVDS-1790-2A	AVDS 1790 -2C
Engine type (No. of cylinders/ arrangement)	gas-turbine	12/90'V	12/90'V
Fuel	multi	diesel	diesel
Max. power output (kw/hp:rpm)	1,100/1,500: 3000		560/750 :2,500
Transmission designation	*1100-3B	CD850-6	CD850-6A
Type	hydrokinetic		crossdrive
No. of gears (forward/reverse)	4/2	2/2	2/1
Steering system	hydrostatic	crossdrive differential	hydro-mech nical
Type of clutch	torque converter	hydro-kinetic torque converter	
Final reduction ratio	4.30:1	5.08:1	5.08:1
Suspension and running gear			
Type of suspension	Hydromechani- cal,torsionbar	torsion bar	torsionbar
Bump travel (mm)	381	206	
No. of shock absorbers per side	3		
No. of roadwheels per side	7	6	6
No. of top rollers per side	2	3	3
No. of links per side	78		80
Track life (km)	2,240		
Electrical system			
Batteries (no/capacity/V)	6/300Ah/12	4/ /12	6/-/24

* Almost same capability of ROK K-1 MBT.

Source: Internation Defense Review, *Battle Tanks,* Supplement to International Defense Review 9, 1985, pp. 64-71.

TABLE 7. NK TANK TYPES AND THEIR CHARACTERISTICS

TANK MODEL	T-54	T-55	T-62
Country of origin	USSR	USSR	USSR
Manufacturer	State arsenals	State arsenals	State
First in service	about 1949	1955	1964
Crew	4	4	4
Combat weight (kg)	35,400	36,400	38,000
Length, gun forwards (m)	9.02	9.02	9.40
Length of hull over tracks (m)	6.27	6.27	6.91
Heigth to top of cupola/sight (m)	2.40	2.40	2.28
Height to turret roof (m)	2.16	2.16	
Ground clearance (cm)	43	43	43
Width of track	56	56	58
Length of track on ground (m)	3.84	3.84	4.05
Max. road speed (km/h)	50	50	50
Max. cross-country speed (km/h)	35	35	35
Road range (km)	620	620	
Fuel capacity (litres)	832		
Max. solpe (%)	58	58	58
Vertical obstacle (m)	0.83	0.83	0.83
Gap crossing (m)	2.70	2.70	2.70
Fording, w/out preparation (m)	1.40	1.40	1.40
Heater	yes	yes	yes
Escape hatch in hull	yes	yes	
ARMARMENT			
Main armament calibre (mm)	100	100	115
Type	rifled	rifled	smooth bore
Length of tube (calibres)	56	56	55
Type of ammunition	APHE, HVAP, HE, HEAT	APHE, HVAP, HE, HEAT	HE-Frag FS, HEAT -FS, HVA-PFSDS
Max. rounds carried	34	43	40
Coaxial armament			
Type	MG	MG	MG
Calibre (mm)	7.62	7.62	7.62
Rate of fire (rounds/min)	650	650	650
No. of rounds stowed			2,000-3,000
Anti-aircraft armament			
Type	MG DSchk		DShk38-46
Calibre (mm)	7.62	7.62	
Rate of fire (rounds/min)	650	650	650
No. of rounds stowed			250

TANK MODEL	T-54	T-55	T-62
Secondary armament			
Type	MG (fixed)	MG (fixed)	
Calibre (mm)	7.62	7.62	
Rate of fire (rounds/min)	650	650	
SIGHTS AND FIRE-CONTROL SYSTEM			
Turret drive	electro-hydraulic	electro-hydraulic	electro-hydraulic
By cdr/gnr	both	both	both
Gun stabilizer	yes	yes	yes
Optical rangefinder/type	yes/stadiametric	yes/stadiametric	yes/stadiametric
Laser rangefinder/type	no	no	no
Ballistic computer	no	no	no
Range setting	graticules	graticules	graticules
Gunner's primary sight	TSh22-2	TSh22-2	TSh2B-41u
Magnification	*3.5 *7	*3.5, *7	*7 (day) *3.5(night)
Field of view (mils)			160, 320
Driver's night sight/type	yes/IR	yes/IR	yes/IR
ENGINE AND TRANSMISSION			
Engine designation	W-54G		
Engine type (No. of cylinders/arrangement)	12/60'V	12/60'V	12/60'V
Fuel	diesel	diesel	diesel
Max. power output (kw/hp:rpm)	390/525:2,200		435/-:-
Transmission destination			
No. of gears (forward/reverse)	5/1	5/1	5/1
Steering system	2-stage planetary single epicyslic clutch	2-stage planetary single epicyclic clutch	2-stage planetary single epocyclic clutch
Type of clutch	multiple	multiple	multiple
Final reduction ratio	6.78:1	6.78:1	6.8=78:1
Suspension and running gear			
Type of suspension	Christie and torsion bar	Christie and torsion bar	Christie and torsion bar

TANK MODEL	T-54	T-55	T-62
Bump travel (mm)			200
No. of shock absorbers per side	2 (1 and 5)	2 (1 and 5)	2
No. of roadwheels per side	5	5	5
No. of top rollers per side	0	0	0

Source: Internation Defense Review, *Battle Tanks,* Supplement to Internatioal Defense Review 9, 1985, pp. 80-86.

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